ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

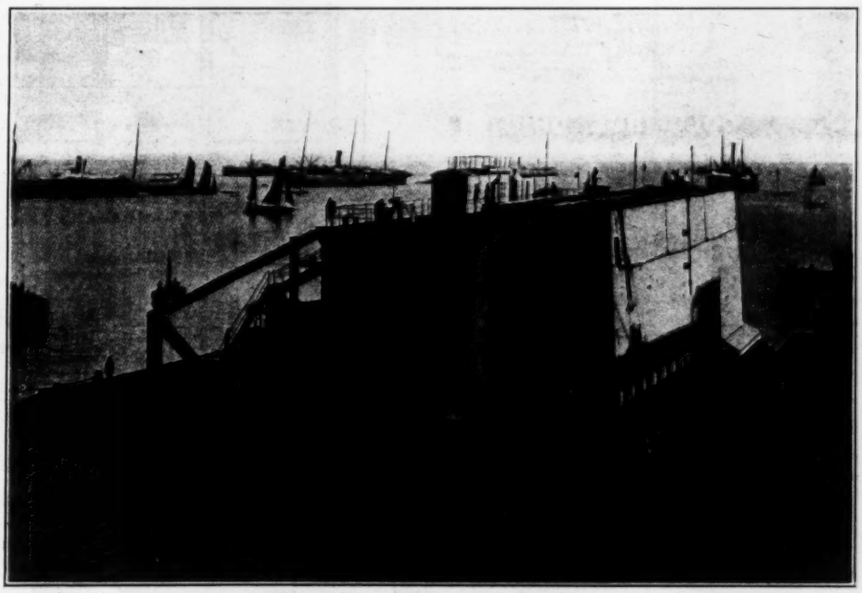
Vol. 65. No. 22. 220 Broadway, New York, June 1, 1911.

TABLE OF CONTENTS.

LEADING ARTICLES:	Page.
Reinforced-Concrete Hollow Caissons Floated Into Place in Piers, Kobe Harbor Works (illustrated)	647
Low-Grade Fuel Deposits in the United States and Their Prospective Use..	648
Building, Bridge and Track-Standards of the Illinois Traction System (illustrated)	649
A Study of the Telephone Situation in Seattle, Wash.; Report by C. H. Judson and F. B. Hall, Engineers	652
Roundout Pressure Tunnel of the Catskill Aqueduct, New York City (illustrated); Alfred Douglas Flinn, M. Am. Soc. C. E.	654
The Locomotives Exhibited at the Brussels Exhibition, 1910	661
The Experimental Imhoff Sewerage Clarification Tank at Philadelphia and the Original Tanks in the Emscher District of Germany; Charles Saville, with Introduction by Rudolph Hering, M. Am. Soc. C. E.	663
The Prevention of Fire; W. H. Merrill	664
A New Cane Sugar Process	664
Law Governing Diversion of Interstate Waters; Carman F. Randolph	670
Mine Fires; Herbert M. Wilson, M. Am. Soc. C. E.	672
The Fire Waste in the United States; Walter L. Fisher	673
Annual Convention of the National Fire-Protection Association	673
Reinforced-Concrete Work in Cold Weather (illustrated); George C. Newton..	674
Honors to a Long Dead Engineer, Pierre Charles L'Enfant	676
New Design of Railway Coaling Station (illustrated)	676
A New Design of Railway Coaling Station (illustrated)	676
Notes from Engineering Schools	677
EDITORIAL	665
A Proposed Niagara Frontier Sewer and Water Commission—Official Representation of the United States at Foreign Congresses and Exhibitions.	
The Law Regarding Control of Waters Crossing State Boundaries	665
Why Absolute Bacterial Standards for Potable Water Are Impracticable	666
LETTERS TO THE EDITOR	667
One of the Problems of the Pyramids (illustrated); D. W. Lockwood—Some Criticisms of Institutions for Higher Education: A Reply; Palmer C. Ricketts—Tests of Beach Shells as Concrete Aggregate; Wayne Cunningham—Water-Waste Prevention in New York City; Winslow H. Herschel—Handling Freight at Way Landings on Small Rivers; William Heer, Jr.	
ENGINEERING NEWS OF THE WEEK	677
PERSONALS	677
ENGINEERING SOCIETIES	678

Reinforced-Concrete Hollow Caissons Floated into Place in Piers, Kobe Harbor Works.

In an article describing the new harbor works now in course of construction at Kobe, Japan, appearing in Engineering News, March 2, 1911, p. 261, it was stated that the main feature of the new construction was the four piers projecting into the harbor from the newly made foreshore. These piers are being built of separately-molded reinforced-concrete caissons cast on shore and floated into place on pier site, where they are sunk and filled with concrete and sand to make the permanent landing and loading stages. This system has been employed somewhat in this country, notably by Maj. W. V. Judson, of the U. S. Corps of Engineers on the Great Lakes,* but the Kobe caissons are much larger than any others that have ever been built and their method of launching is quite novel. The following description of their manufacture and installation is taken largely from "The Engineer," of London, March 24, 1911.



DEPOSITING DOCK CARRYING CONCRETE CAISSON PREPARATORY TO LAUNCHING, KOBE HARBOR, JAPAN.

Fig. 1 shows the details of the caissons proper. They are of the typical open-top box design, 24 to 30 ft. wide at the bottom, tapering to a uniform top width of 24 ft., and 35 ft. 6 ins. to 41 ft. 6 ins. high, depending upon the depth where sunk, and 119 ft. long. Each box is divided into 20 separate cells, longitudinally by one wall and transversely by nine walls, the dimensions and reinforcement of the walls being shown in Fig. 1. They are joined together in the finished pier with the long side in the line of the pier, making the top width 24 ft. About 9,500 ft. of piers are to be required so that the contract calls for 79 caissons.

The molding of the caissons is done on a timber pile framework built near the shore in about 25 ft. of water, with the flooring above water level. Three of these platforms are provided, each with permanent forms on the shore side and with demountable forms on the harbor side. On each of the platforms the casting of a caisson is carried on simultaneously, when each one is completed, allowing three months for the fabrication and setting, a specially designed depositing dock is floated underneath the caisson and it is carried out to deep water, where the dock is sunk until the caisson floats. Then it is towed to its proper position in the pier and sunk into place on a specially prepared solid bottom.

The design of the depositing dock is shown in Fig. 2. It is a steel structure consisting primarily of a floating platform on which is mounted four trussed frames, pin connected to fixed points at the upper and lower part of a hollow dock, which can be emptied or filled with water. The dock can thus be raised and lowered at will, being held in position by its pin connection to the floating platform, upon which all the operating machinery is mounted. The front end of the raising dock is divided into eight sections separated from each other by 4 ft. 6-in. openings, forming a plan somewhat like the teeth of a comb. The pile foundations of the molding platforms are so arranged that these "teeth" go in between the rows of piles, when the dock is floated under the finished caissons. The dock is then pumped out and consequently rises until the caisson rests on a specially prepared I-beam grillage on the floor of the dock. It is then floated two or three hundred feet off shore and the dock pumped full enough so that it sinks from under the caisson, which is then floated to its proper location. This process is shown diagrammatically in Fig. 3, and a view of it floating a caisson given in the view on this page.

The dock was built by the Kawasaki Dockyard Co., of Kobe, at a cost of about $135,000, according to designs and patents of Messrs. Clark and Standfield, of Westminster, Eng. The machinery of the dock consists of two single-cylinder engines, each driving a centrifugal pump, the engines taking the steam from boilers placed on the outriggers boxes at the back of the dock. The pumps are capable of lifting a block off the stage in two hours. Although the one dock serves all three of the molding platforms, it is evident that it is idle most of the time.

The work is being done by the Japanese Government.

*Engineering News, Oct. 13, 1908, p. 421; July 8, 1909, p. 34.

Low-Grade Coal Deposits in the United States and Their Prospective Use.

In an address before the American Philosophical Society, at Philadelphia on May 5, Dr. J. A. Holmes, Director of the U. S. Bureau of Mines, gave the following figures on fuel deposits of lignite character.

In the Rocky Mountain region there are large fuel deposit that represent a transition between typical lignite and bituminous coals. For these, the name "sub-bituminous coals" has been suggested, and is tentatively used by the U. S. Geological Survey.

AREAS OF DEPOSITS; SQUARE MILES.

	Lignite.	Sub-bituminous.
Alabama	6,000	....
Tennessee	1,000	....
Louisiana	8,800	....
Arkansas	5,900	....
Texas	53,000	....
South Dakota	4,000	....
North Dakota	31,000	....
Montana	7,000	8,800
Wyoming	....	21,360
Washington	....	1,100
New Mexico	....	5,000
Colorado	....	5,910
Idaho	....	1,200
Total	116,700	43,370

The beds in Texas and the Dakotas are typical lignites, but those in Alabama, Mississippi and Tennessee represent a transition between peat and true lignites.

Little use has been made of the lignites in the latter states, though there has been a limited utilization of this fuel in Texas, Arkansas, the Dakotas and eastern Montana. There is a favorable outlook, Dr. Holmes reports, for the use of lignite fuel, along these lines: (1) in gas producers; without either drying or other treatment; (2) in boilers of special construction; such, for example, as that installed more than a year ago at Williston, North Dakota, by the U. S. Reclamation Service,* where lignite is used in its natural condition almost immediately after being brought from the mine; (3) in the form of briquettes. This last requires that the lignite should be thoroughly and finely crushed and dried to a moisture content of from 5 to 10%, and then compressed into briquettes while still warm.

Limited quantities of lignite from California, North Dakota and Texas have been made into satisfactory briquettes at the U. S. Mine Experiment Station at Pittsburg, using a full-sized German briquetting press, which develops a pressure of about 25,000 lbs. per sq. in. In the cases mentioned, a sufficient amount of tarry material, remained in the crushed and dried lignite to serve as a bond to hold the particles together in the briquette.

It is believed that the lignite in Texas, the Dakotas, and Montana can be made into briquettes on a commercial scale, and that these can be used as a substitute in these regions for other domestic fuel which is high in price.

*Described in Engineering News, March 23, 1911; results of tests on lignite fuel also given.

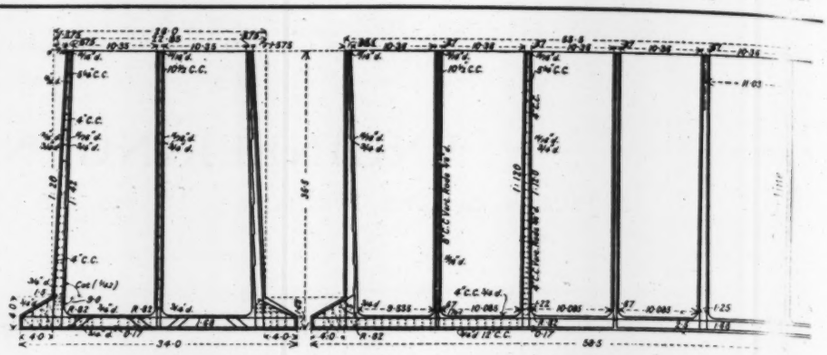
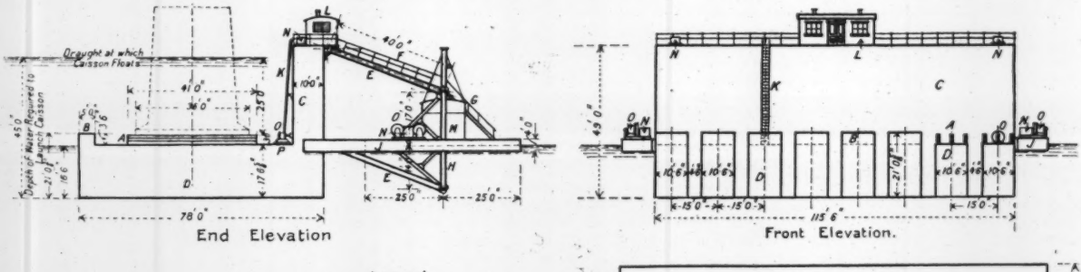


FIG. 1. DETAILS OF REINFORCED-CONCRETE CAISSONS FOR PIERS, KOBE, JAPAN.


End Elevation
Front Elevation.
Legend.
Timber Blocks ... Marked ... A
Air Boxes ... " ... B
Side Wall ... " ... C
Pontoons ... " ... D
Booms ... " ... E
" Gangway ... " ... F
Companion Ladder ... " ... G
Boom Column ... " ... H
Outrigger Box ... " ... J
Ladder ... " ... K
Valve & Engine House ... " ... L
Boiler House ... " ... M
Windlass Engines ... " ... N
Drums ... " ... O
Fairleads ... " ... P

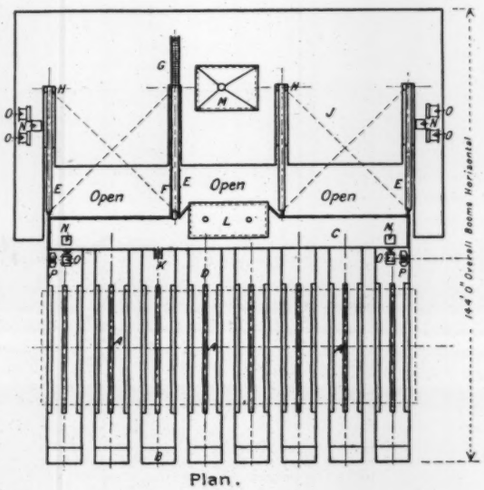


FIG. 2. DEPOSITING DOCK USED FOR LAUNCHING CONCRETE CAISSONS.

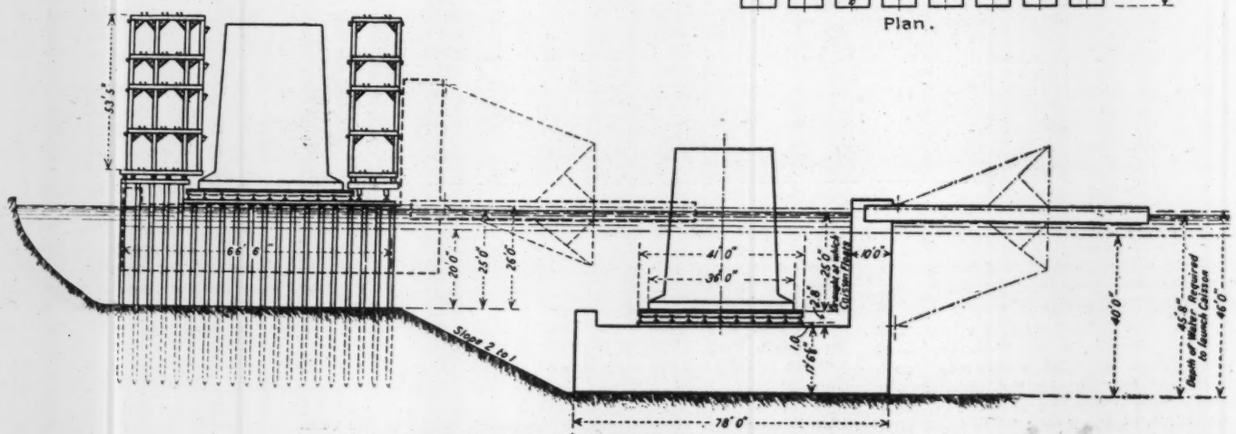


FIG. 3. DIAGRAM SHOWING METHOD OF LAUNCHING CAISSON.

Building, Bridge and Track Standards of the Illinois Traction System.

The development of electric interurban railways to long lines and extensive systems is bringing about the adoption of standard designs for ... structures and equipment, partly for the ... of uniformity and reduction of expense, and ... ly as an improvement upon older and less ...factory designs. The Illinois Traction System, which has an extent of over 500 miles of interurban lines (besides several miles of street railway lines in various cities and towns) has taken up this matter, and a number of standards have been adopted for track and structures as well as for rolling stock and electrical equipment. The standards for smaller structures, such as shelters, section tool houses, fences, track signs, etc., have been carried out over the entire system. There are of course a number of large and important structures which cannot be included, and are of special design in each case. These include steel bridges (although standard designs of plate girder spans may be adopted), the new passenger and freight terminal stations at St. Louis, Mo., and a large freight and storehouse at Granite City, Ill. The standardizing has been carried out under the direction of Mr. H. E. Chubbuck, General Manager. We illustrate and describe herewith a number of the standards, for drawings and information as to which we are indebted to Mr. E. M. Haas, Superintendent of Bridges and Buildings, and Mr. L. B. Martin, Engineer of Maintenance of Way.

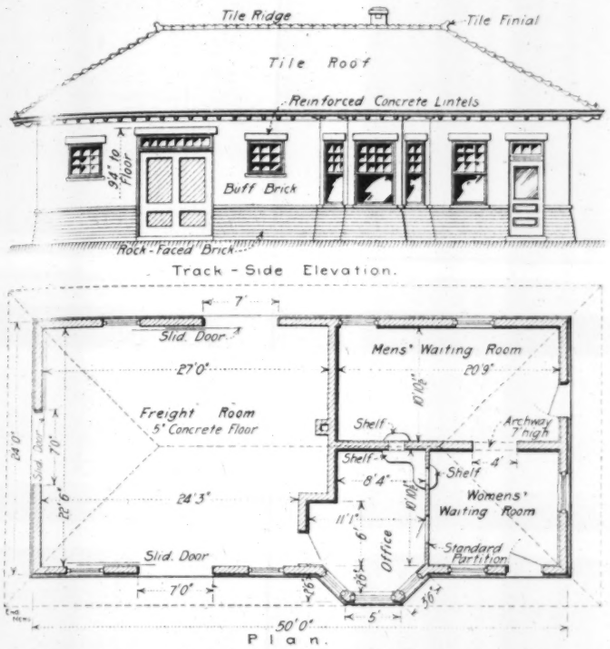


FIG. 1. STANDARD DESIGN OF BRICK STATION: ILLINOIS TRACTION SYSTEM.

Buildings.

PASSENGER AND FREIGHT STATIONS.—The standard design (for towns of about 1,000 to 3,000) is a one-story brick structure, with concrete foundation, steel roof trusses and tile roofing. The lintels are rectangular beams of reinforced concrete, and the chimney caps also are of concrete. The building is 50 × 24 ft., and includes an office (with bay window commanding a view of the platform and track); men's waiting room, 20 ft. 9 ins. × 10 ft. 10 ins.; women's waiting room, 12 × 10 ft. 4 ins.; and freight room 27 × 20½ ft. This last room has a 5-in. concrete floor and wide doorways with sliding doors; its walls are not plastered. The doorways have concrete lintels 8 ft. long, 7 × 7½ ins., with three 1-in. rods at the bottom. There is no toilet accommodation, the water closets or privies being located in separate frame buildings (of standard design). The plan and elevation are shown in Fig. 1, while Fig. 2 shows the details of wall, eaves and gutter. There are now five stations of this design on the system. Their average cost is about $3,000 (or $4,000 with fixtures and furnishing complete).

The standard design of station for towns having a population of about 300 to 1,000 is a one-story frame building 36 × 16 ft. with shingle roof, shown in Fig. 3. There are already five stations of this design. Their average cost is about $1,200. They are used where the business does not warrant a large expenditure, and where the chances of fire are very limited.

COMBINED STATION AND SUBSTATION.—These buildings are of two types: (1) with waiting room and freight room occupying one end of the building (each being half of its width), and the remainder being devoted to the machinery; (2) with waiting room and freight rooms at opposite ends, and the machinery room in the middle. The former arrangement (Harristown, Ill.) is shown in Fig. 4. The structural design is similar to that of the passenger station, but there is a square tower to receive the cables of the transmission line. The openings for the cables are fitted with concrete rings, and within the tower is a steel framing, as shown in Fig. 5. On the track side of the building (which is set 25 ft. from the center line of the track) is a concrete platform extending the full length of the building. Tickets are issued by the station attendant, a window for that purpose being provided in the waiting room partition. There are now six of the first class and three of the second class of these combination stations and substations. The same designs will be followed in building new ones or rebuilding old ones.

SHELTERS AT ROAD CROSSINGS.—These are of different designs to meet different conditions. For ordinary roadside stops, a frame building 8 × 9 ft. is used, with composition roofing. The front wall is set back 4 ft. within the side walls, leaving room for sheltered outdoor seats. These structures (Fig. 6) cost about $75 each (with concrete floor and platform), $45 for material and $30 for labor. For suburban stops, where the number of passengers is larger and more regular the building is 12½ × 12 ft. (with room 6 × 11 ft.), and of more ornamental design (Fig. 7). Concrete foundation walls are used, and there is a concrete platform 8 ft. wide and 30 ft. long. The total cost, including foundations and platform, is about $300. For parks, single-post and double-post canopies are used, as shown in Fig. 8. The posts (12 × 12 ins.) are set 4½ ft. in the ground, in a hole 2 ft. diameter and 5 ft. deep, filled with concrete.

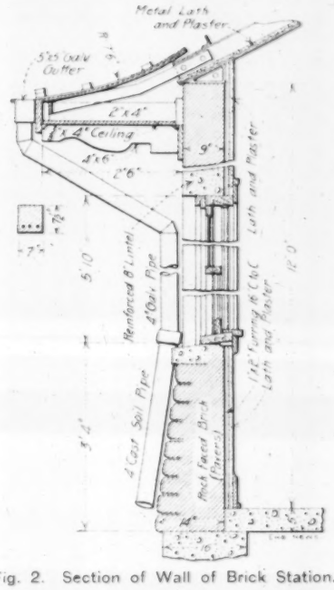


Fig. 2. Section of Wall of Brick Station.

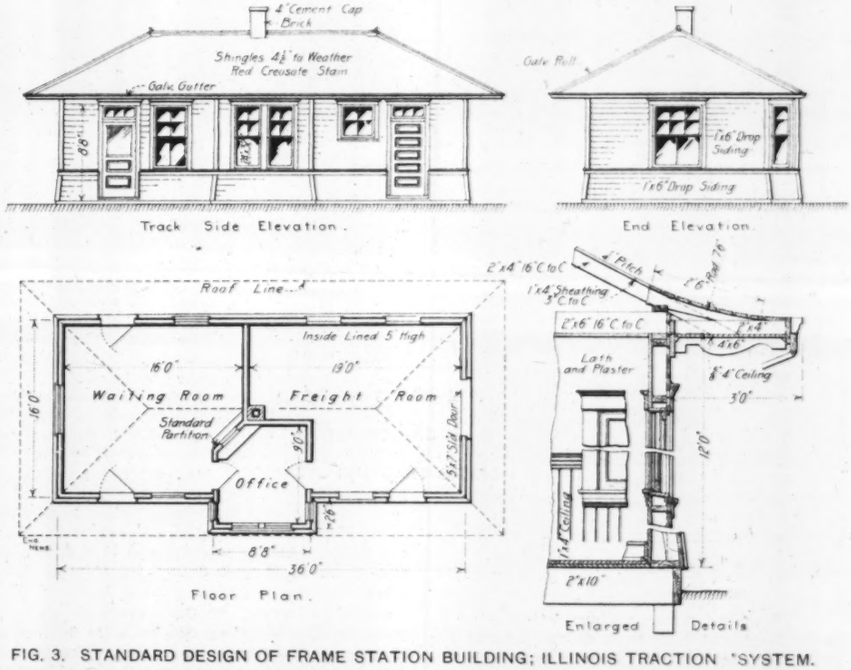


FIG. 3. STANDARD DESIGN OF FRAME STATION BUILDING; ILLINOIS TRACTION SYSTEM.

Where freight is handled at road crossings, a platform 18 × 24 ft. is built, 4 ft. above rail level; this is covered by a shed roof and has an enclosed section 12 × 12 ft. for a freight room (Fig. 9). Where milk is handled, a platform 8 × 16 ft. is built, 4 ft. above the ground, and with its longer side 7½ ft. from center of track.

STOCK CHUTES.—The standard stock chute (Fig. 10) has a runway 20 ft. long and 4 ft. wide. The posts are 5 ft. apart and the last 5-ft. bent is level, 4 ft. 3 ins. above the rail level. The end posts are 7 ft. clear from center of track. A hinged section forms an apron extending to the car door, and folds back on the floor of the chute when not in use. Sliding gates are run out on either side of this apron to extend the chute to the car. The sides are 5¼ ft. high, with five lines of 1 × 6 fence planks. The average cost is $25 for material and $15 for labor.

For loading stock at farm crossings, etc., portable chutes are used. Each is composed of three parts: a floor and two side pieces. The floor has eight 2 × 6-in. planks, 11 ft. long bolted to three cross pieces, one of the latter having hooks to fit in the groove of the car door. The side pieces are like braced fence panels, and the feet of the three posts (2 × 4 ins.) fit into iron stirrups or stake pockets in the cross pieces of the floor. The average cost is $10 for material and $10 for labor. These portable chutes are kept at central points and picked up by the cars used for transporting stock.

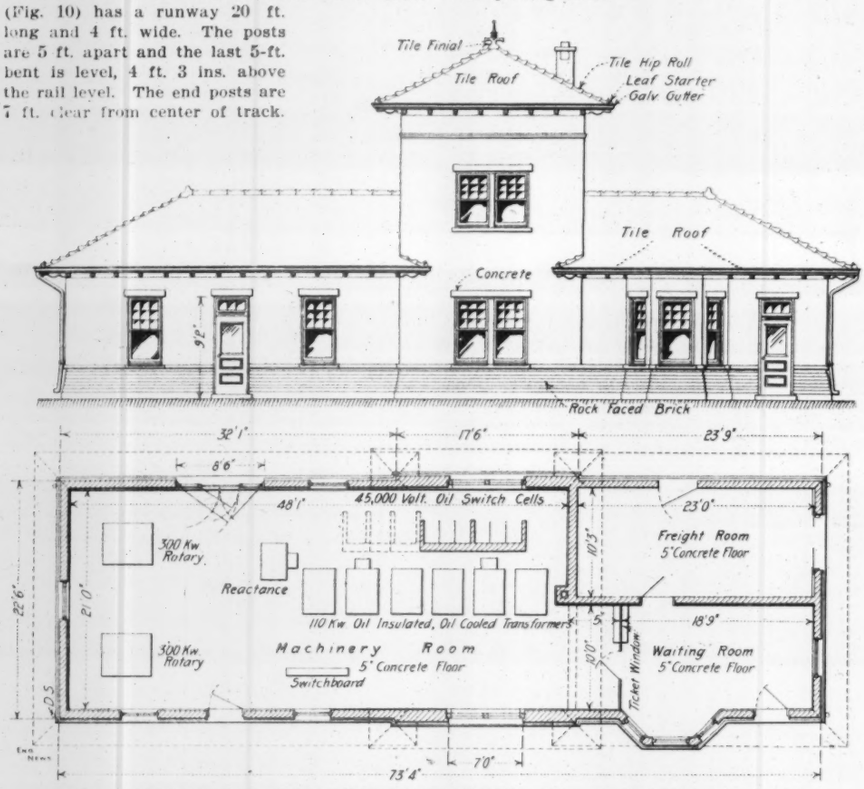


FIG. 4. STANDARD DESIGN OF COMBINATION STATION AND SUBSTATION; ILLINOIS TRACTION SYSTEM.

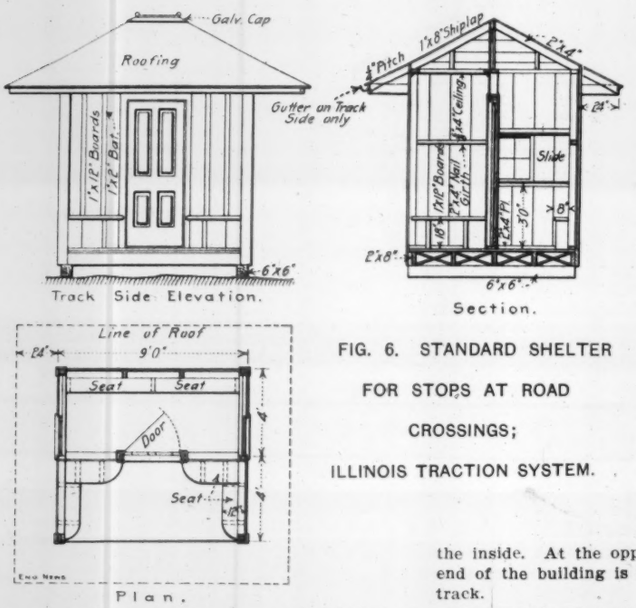
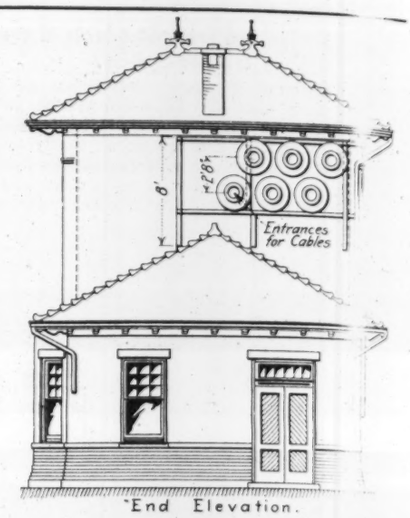


FIG. 6. STANDARD SHELTER FOR STOPS AT ROAD CROSSINGS; ILLINOIS TRACTION SYSTEM.

COAL HOUSE. — The standard coal house at stations is a frame building 12 × 9 ft. outside measurement, with walls 7½ ft. high and pitched roof 3 ft. 8 ins. high. The frame is of 4 × 4-in. sills and corner posts, with 2 × 4-in. studs and wall plates. Vertical planks 1 × 10 ins. are spiked to the sills (4×4 ins.) and wall plates and have battens nailed over the joints. The inside is sheathed to the height of the wall plate with horizontal fence plank 1 × 6 ins. The roof has 1 × 6-in. sheeting and composition roofing. In the gable end facing the track is a coal door 2 ft. square hinged at the bottom and fastened on the inside. At the opposite end is a door. The end of the building is 8 ft. 6 ins from center of track.

SECTION TOOL HOUSE.—This is a frame building 12 × 9 ins. outside, with its floor raised to the rail level by cinder filling. The sills are drift-bolted to short posts, and the outside sheeting is carried down to the ground to retain the filling. The long side is set parallel with the track and 14 ft. from the center line. In this side is a double swing door for the hand car. The inside is sheeted to a height of 3½ ft., and has bins and racks for tools, scrap, etc. The average cost of these buildings is about $70. Their construction is shown in Fig. 11.



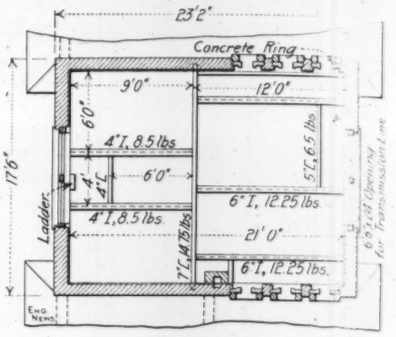
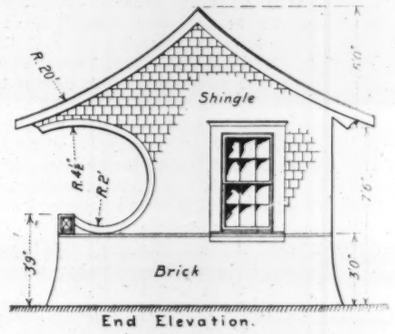


Fig. 5. Tower of Substation to Accommodate Transmission Cables.

The standard color design for all wooden stations and buildings is buff for the body color and olive green for the trim. These colors are prepared from a special formula.

Subways, Culverts and Trestles.

Subways for carrying the line under other railways are of the reinforced-concrete slab-girder



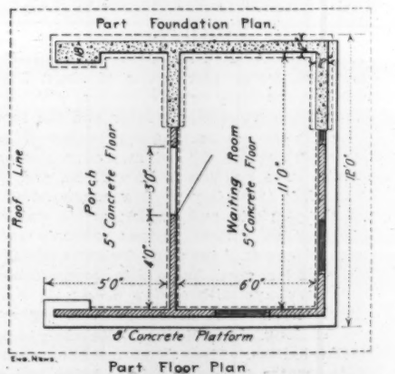


Fig. 7. Standard Design for Ornamental Shelter.

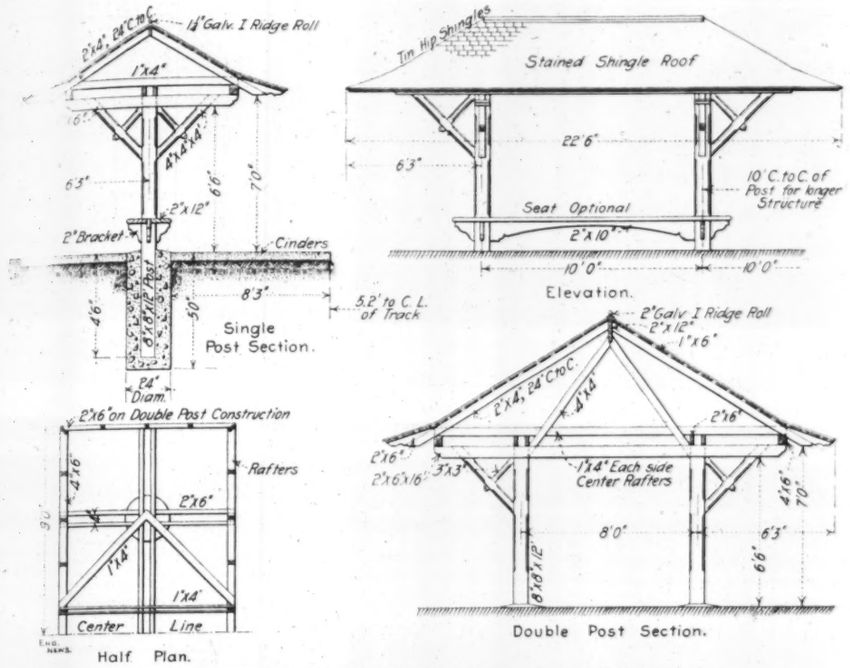


FIG. 8. STANDARD DESIGNS OF CANOPIES FOR PLATFORMS AT PARKS, ETC.; ILLINOIS TRACTION SYSTEM.

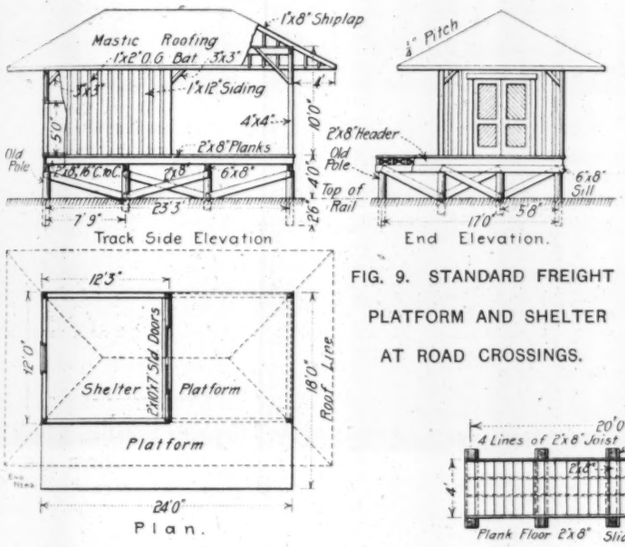


FIG. 9. STANDARD FREIGHT PLATFORM AND SHELTER AT ROAD CROSSINGS.

type with a clear width and headway of 18 ft. Fig. 12 shows the construction of a subway under a double track line at Decatur, Ill., and this is fitted with a hand rail as it is within the yard limits of the steam railway. This has about 720 cu. yds. of concrete in the two abutments and 55 cu. yds. in the slab. The steel reinforcement consists of square lug-type open-hearth steel bars. At the bottom of the slab there are 1-in. longitudinal rods 3½ ins. apart, and ½-in. transverse bars 24 ins. apart. Alternate 1-in. bars are bent up at the ends, as shown. At the top of the slab there are ¾-in. longitudinal bars 18 ins. apart and ½-in. transverse bars 24 ins. apart. At the lower corner of each face of the slab is an angle 6 × 6 ins., 6 ft. long, for the attachment of the trolley wire hangers and to protect the corner of the slab. A similar but lighter design is used for highway overhead crossings. The first cost is relatively low, owing to the simple construction and the lack of mill work on the forms. Maintenance cost is practically eliminated.

The standard concrete barrel culvert (Fig. 13) is 4 ft. wide and 3 ft. 9 ins. high at the center, the floor sloping 3 ins. from the sides to the center. The 9-in. floor is extended to the end of the wing walls and has a 3-ft. cut-off wall. These culverts are used with a minimum cover of 4 ft. of embankment above the crown. Where greater waterway is required a similar culvert is used, but 5 ft. wide and 4 ft. 9 ins. high (4-in. invert). This has 1 cu. ft. of concrete per lin. ft. of barrel; and 13 cu. yds. in the wings, apron and parapet (including barrel in the parapet wall). It is used for a maximum drainage area of 300 acres. The culvert design is simple and no coping is used on the wing walls. This means a low cost for forms and less chance for defects in the concrete work. Some railways are now building the wing walls of bridge abutments without coping.

The standard pile trestle has bents 13 or 16 ft. c. to c. Each bent has two vertical piles and two batter piles, a cap, two sway braces, and a horizontal cross brace just above the ground. The packed stringers rest on corbels. The sawed ties are 6 × 8 ins., 4 ins. apart, and have outside guard timbers 6 × 8 ins. Inside guard rails consist of old 40-lb. rails, laid with 8-in. flangeway; they extend 50 ft. beyond each end of the bridge, the ends of the rails being brought together at these points.

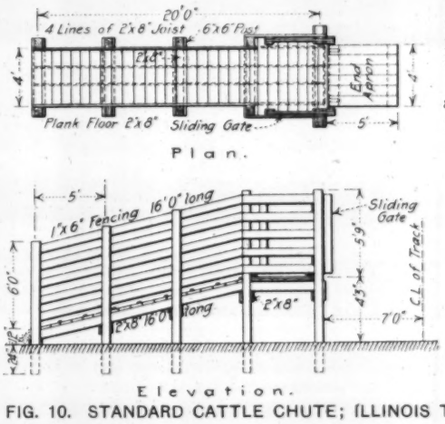


FIG. 10. STANDARD CATTLE CHUTE; ILLINOIS TRACTION SYSTEM.

Track Standards.

The standard track construction was described in our issue of Oct. 27, 1910. It consists of 70-lb. rails spiked to ties 6 × 8 ins., 8 ft. long (18 to a 30-ft. rail length), and laid on 8 ins. of gravel ballast. The standard split switch has 15-ft. switch rails, each reinforced by a ⅜-in. bar riveted to the inner side of the web for a length of 15 ft. from the point; these rails are connected by two tie-bars ¾ × 2½ ins. The six ties carrying the moving portion of the switch rails have steel slide plates, and over the next tie is a stop riveted to the switch rail and bearing against the web of the stock rail when the switch is set. The throw of the switch is 4½ ins., and the bend of the turnout stock rail is made 8 ins. ahead of the point. The No. 9 spring rail frog is 15 ft. long, with a double spring on each side of the throat. The width of throat and flangeway is 1¾ ins. The fixed point is held by a steel clip. The moving rail is guided by two socket guides, and its movement is limited also by a clamp opposite the throat. A raising block is fitted at the heel, and an anti-creeping device is fitted in advance of the toe. Opposite the frog is a 10-ft. guard rail, straight for 6 ft. 8 ins. and secured to the track rail by three bolts with spacing blocks. The flangeway is 1¾ ins. flaring to 4¼ ins at the ends.

The crossing frogs are of the riveted plate type, with rails bolted together and forged reinforcing straps or knees bolted at all corners. For angles of 9½ to 25° each track has an inside guard rail along one of its rails. For angles of 25° to 90° the guard rails are continuous in the space between the frogs, while outside easier rails are bolted against the rails of the steam track (or both tracks). While the Maintenance-of-Way Department has its standards for switches, frogs and crossings, modifications are permitted to suit the shop practice of the different manufacturers.

WING FENCE AND CATTLE GUARD.—The wing fences at road crossings have 8-ft. panels and a 4-ft. triangular panel; across the latter is laid a triangular apron panel parallel with the rails, and at an angle of 45° from the vertical. The fence has 26-in. woven wire fencing with two top boards and a cap board. The standard cattle guard is 8 ft. long composed of triangular slats of oak nailed to cross pieces which are spiked to the tie. The construction is shown in Fig. 14.

STANDARD TRACK SIGNS.—The standards of the Bridge and Building Department include the various track signs required for various purposes, and some of the typical designs are shown in Fig. 15.

The "stop" sign for crossings is a post with a fixed red arm or blade lettered "Stop." The post is black and the back of the arm is white; this is set 250 ft. from the crossing and 9 ft. to the right of the center of track. The "slow" sign (set 750 ft. in advance of the "stop" sign) is similar, but with a fixed green blade inclined upward at 30° and lettered "Slow." The section sign is somewhat similar, but with two short boards back to back for the section numbers. It would be simpler, however, to use one board, lettered on both sides. This is set 8½ ft. from the center of track. The property post is a plain post set at the corners of right-of-way and lettered vertically "I. T. S." The road crossing sign has a post with two boards crossed in the usual way. This is set 25 ft. from the track, at right angles to the highway, and is lettered on both sides. It may be noted that the Indiana Railway Commission now requires crossing signs to be supplemented by a horizontal board lettered "Danger" in red letters.

Several signs have board targets bolted to posts of the type shown by the "subway" sign (Fig.

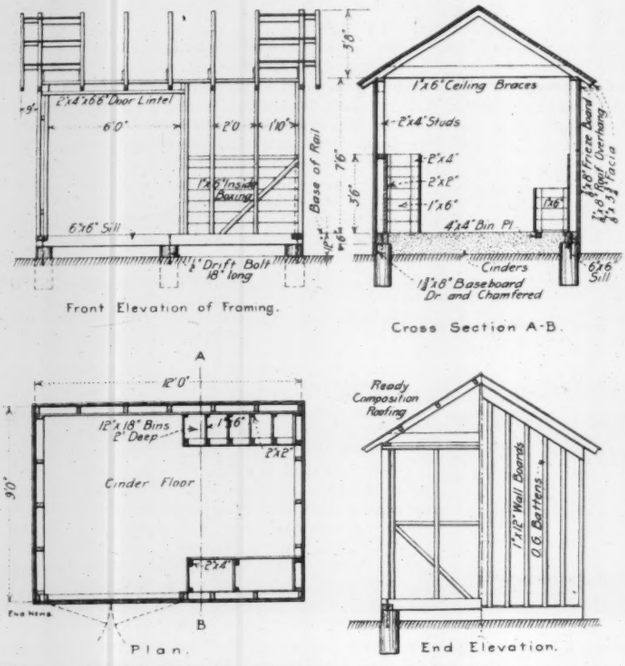


FIG. 11. STANDARD SECTION TOOL HOUSE; ILLINOIS TRACTION SYSTEM.

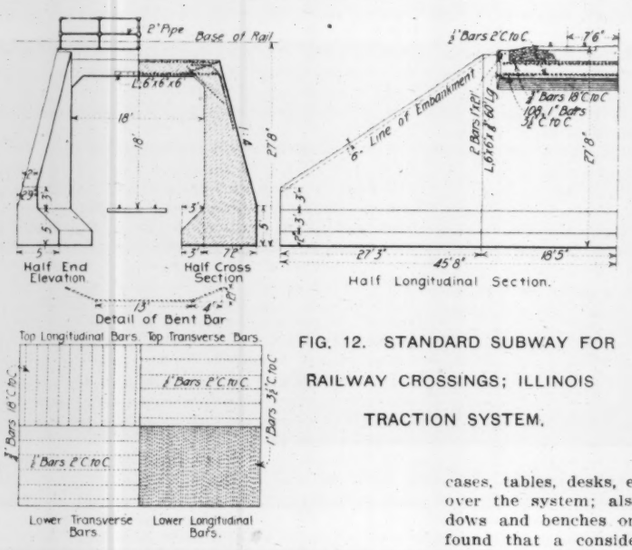


FIG. 12. STANDARD SUBWAY FOR RAILWAY CROSSINGS; ILLINOIS TRACTION SYSTEM.

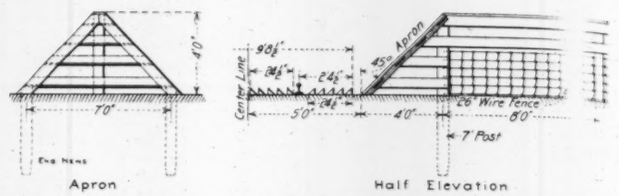


FIG. 14. STANDARD WING FENCE AND CATTLE GUARD AT ROAD CROSSINGS.

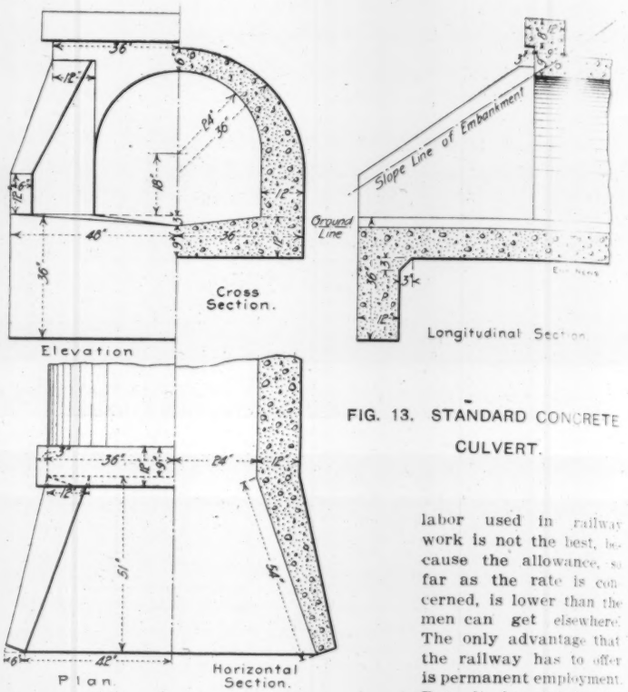


FIG. 13. STANDARD CONCRETE CULVERT.

15). The board is white, with black for the letters, back and post. Other of these signs are "Danger, Keep Off the Bridge" (same as subway sign but inverted); "Yard Limits" (oval, 39½ × 21½ ins.); "Railway Crossing 800 ft." (rectangular, 36 × 24 ins.); and trespassing signs with rectangular boards 42 × 20 ins. Each board has two 5-16-in. copper rods passed through it vertically and riveted over, to prevent splitting. The signs are set 8½ ft. from the center of the track, as a rule, and an unusual feature is that all posts are painted black.

A number of the signs are boards attached to the trolley poles. The name board for intermediate points at which local cars stop is shown. The siding name is on a single board 36 × 15 ins. set 400 ft. from switch or stub end; this has a vertical piece at the back to fit against the face of the pole (with single lag screw) and hold the sign more securely. The mile sign is similar, but is simply held to one side of the post by two 4-in. lag screws. The "whistle" sign is a square board set diagonally on the pole at 800 ft. from the crossing. This has a molding, which is a rather unnecessary refinement. The station name board is 1¼ × 11½ ins., and of the necessary length (letters 8½ ins. long and 7 ins. high). The board is black (sanded) with yellow letters and red chamfered edges.

The company has gone into the furniture business to a certain extent in connection with its standards. It constructs various kinds of file cases, tables, desks, etc., for the different offices over the system; also ticket cases, ticket windows and benches or seats for stations. It is found that a considerable saving in money is made in this way. For instance, the company can construct a substantial type of all-wood station seat, including material and labor, for about 25 cts. per ft.; about the cheapest that it can purchase from a furniture concern is made with oak slats and steel legs, and this costs $1 per ft. A standard partition is used where it is desired to provide a large stove in the waiting room and to transmit the heat into the ticket office. This has been a success, and it is being put in practically all of the smaller way stations. The bottom is solid to a height of 4 ft., and above this (for a similar height) are vertical slats 1 × 1¾ ins., spaced 1½ ins. apart. Above this again the partition is solid to the ceiling.

As much of the work as possible is being standardized. The preparation of a bill of material for each piece of work is eliminated, because this bill is provided usually on the print of the standard drawing, or carried as a record in the office where the bill is too large. This enables a plan to be furnished without drafting charge, and when the mechanics have had the experience with one piece, it does not require experts to follow the details thereafter. The class of carpenter labor used in railway work is not the best, because the allowance, so far as the rate is concerned, is lower than the men can get elsewhere. The only advantage that the railway has to offer is permanent employment. But it is stated that the cheaper class of mechanics, by doing the same thing over continually become experts at it, and can turn out as good a job as a first class carpenter.

A Study of the Telephone Situation in Seattle, Wash.; Report by C. H. Judson and F. B. Hall, Engineers.

The report of Messrs. C. H. Judson and F. B. Hall, Engineers, to the Department of Public Utilities of the City of Seattle, on the value of telephone properties and cost of service in that city has recently been made public. The following information is extracted from the report to show the investment required and the cost of service as compared with the income from various subscribers.

The Engineers set out, under instructions, to find the probable cost to the companies of the plants of the Pacific Telephone and Telegraph Co. (Bell system) and the Independent Telephone Co. The time allotted, however, was so short that a complete independent inventory by the Engineers was impossible. The companies therefore were called upon for data which would give the desired information, and those secured were checked by the Engineers, more or less completely in various limited cases, to judge of their accuracy. The figures of the Independent company were easily secured, but those of the Pacific company were not obtained until after the time for the investigation closed, as such data had to be obtained from the San Francisco office of the company.

It is stated that there has been little study of the actual cost of the service with the view in mind of adjusting the rates to the costs. The practice has been rather to divide the custom-

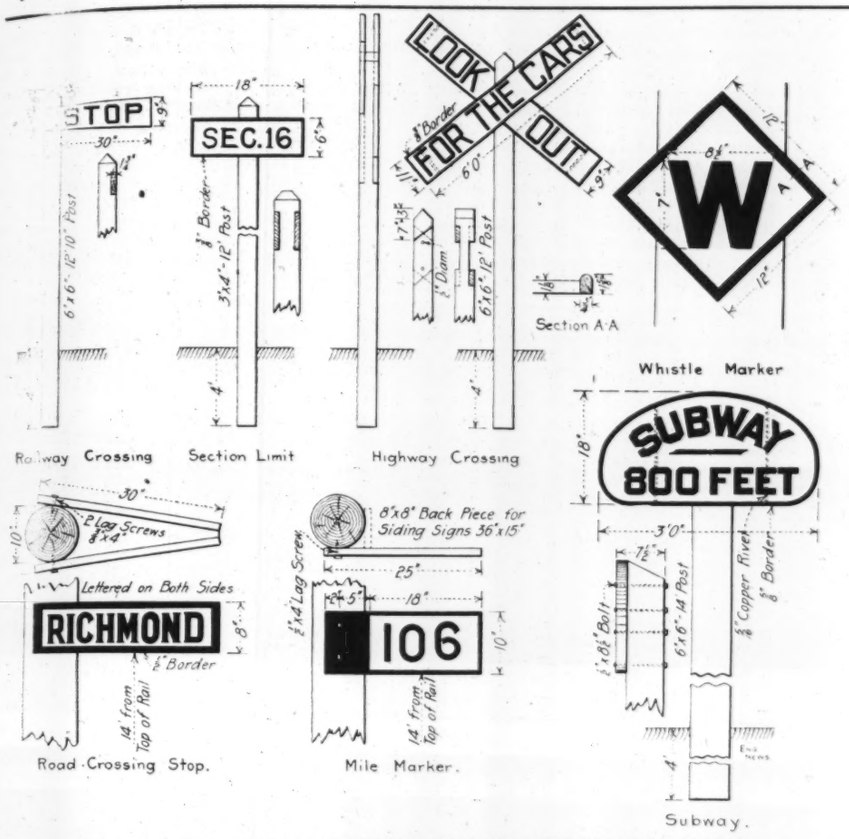


FIG. 15. TYPES OF STANDARD TRACK SIGNS; ILLINOIS TRACTION SYSTEM.

into service classes and charge to each class all that the traffic would stand.

It is found that the city of Seattle is not developed to the point where the zone system of operation (see Engineering News, Oct. 20, 1910, p. 411) could be put into use. Depreciation was not covered by the companies satisfactorily to the Engineers and additional sums were allotted in figuring cost of service. These allowances were made up in accordance with the tables of the Chicago Telephone Co., the Chicago Telephone Commission, and Engineers of the Washington State Railroad Commission. The assumption was made that one-third of the plant had been in use eight years on an average and two-thirds for three years, where actual installation records were not available.

In completing the valuation, the prices of materials used were secured from manufacturer's agents and dealers (f. o. b. Seattle) at present market prices. To these were added 10% for engineering and superintendence, 10% for general expense and 6% for interest. Where contracts were available for exchange apparatus the costs named therein were taken, plus 10% for engineering and superintendence.

Readers of the report are reminded that the area of Seattle is 85 square miles and its population 252,000. The total number of subscribers carried by the Independent company was 18,027, of which 12,414 represented main substation and 5,613 were extensions (private branch exchanges). The Pacific company (Bell system) had 28,835 subscribers, of which 18,413 represented main stations and 6,100 (approximately) extension instruments (from record of May 10, 1910, submitted after Sept 23, 1910). In the city there are over 500 miles of pole lines, 228 miles of underground conduit, 85,000 miles of wire in cables and 8,900 miles of open wire on poles. Of these totals the Independent company had 343,577 duct. ft. of all kinds and 171 manholes, 250 miles of pole lines and 35,000 miles of wire in cables.

The Independent company was reported to have property valued at $2,091,672, with a depreciated value of $1,484,113. As intangible assets $175,000 was allowed, divided into (1) bond discounts, $100,000, (2) working capital, $50,000, (3) cost of early soliciting, $25,000.

In computing the costs of service shown below it has held that General Expense, covering administration, accounting, soliciting, collecting, rarely varied for any class of service. Maintenance Expense varied only as the number of telephones on a line increased, the average for business service running slightly under that for residence service in cost of locating trouble, but slightly heavier in number of faults reported. Operating Expense was held to vary directly with the load on the operator, for any given exchange, though varying slightly for the different exchanges. It was found that the general expense, per station, rarely increased as the plant expanded, but that cost of operation and maintenance, per station, increased with longer lines and greater service.

The annual cost and income figures found to hold for the Independent company are given as follows:

DIRECT-LINE BUSINESS SERVICE.		
General expense	$4.45	
Maintenance	5.01	
Operation	16.30	
		$25.76
Taxes, insurance, depreciation, etc.		10.23
Total		$35.99
Investment per station		$135.35
Income less shrinkage		47.54
Surplus over expense		11.55
Surplus in per cent. of investment		8.5
TWO-PARTY BUSINESS SERVICE.		
General expense	$4.45	
Maintenance	4.19	
Operation	12.22	
		$20.86
Taxes, insurance, depreciation, etc.		8.02
Total		$28.88
Investment per station		$103.02
Income less shrinkage		41.58
Surplus over expense		12.70
Surplus in per cent. of investment		12.3
FOUR-PARTY BUSINESS SERVICE.		
General expense	$4.45	
Maintenance	3.78	
Operation	9.78	
		$18.01
Taxes, insurance, depreciation, etc.		7.12
Total		$25.13
Investment per station		$86.86
Income less shrinkage		33.64
Surplus over expenses		10.51
Surplus in per cent. of investment		12.1
DIRECT-LINE RESIDENCE SERVICE.		
General expense	$4.45	
Maintenance	5.01	
Operation	6.11	
		$15.57
Taxes, insurance, depreciation, etc.		10.23
Total		$25.80
Investment per station		$135.35
Income less shrinkage		29.70
Surplus over expense		3.90
Surplus in per cent. of investment		2.9
TWO-PARTY RESIDENCE SERVICE.		
General expense	$4.45	
Maintenance	4.19	
Operation	4.89	
		$13.53
Taxes, insurance, depreciation, etc.		8.02
Total		$21.55
Investment per station		$103.02
Income less shrinkage		23.76
Surplus over expense		2.21
Surplus in per cent. of investment		2.1
FOUR-PARTY RESIDENCE SERVICE.		
General expense	$4.45	
Maintenance	3.78	
Operation	3.60	
		$11.83
Taxes, insurance, depreciation, etc.		7.14
Total		$18.97
Investment per station		$86.86
Income less shrinkage		20.79
Surplus over expense		1.82
Surplus in per cent. of investment		2.1
PAY STATIONS.		
General expense	$4.45	
Maintenance	6.97	
Operation	9.78	
		$21.20
Taxes, insurance, depreciation, etc.		10.62
Total		$31.82
Investment per station		$145.35
Income less shrinkage		58.80
Surplus over expense		26.98
Surplus in per cent. of investment		18.6
PRIVATE BRANCH AND INTERCOMMUNICATING TRUNKS.		
General expense	$4.45	
Maintenance	5.01	
Operation	16.30	
		$25.76
Taxes, insurance, depreciation, etc.		10.23
Total		$35.99
Investment per station		$135.35
Income less shrinkage		47.52
Surplus over expense		1.53
Surplus in per cent. of investment		8.5
PRIVATE-LINE TELEPHONES.		
General expense	$2.23	
Maintenance	4.82	
		$7.05
Taxes, insurance, depreciation, etc.		7.98
Total		$15.03
Investment per station		$108.32
Income less shrinkage		47.52
Surplus over expense		32.49
Surplus in per cent. of investment		30.0
EXTENSIONS.		
Maintenance		$0.80
Taxes, insurance, depreciation, etc.		1.81
Total		$2.61
Investment per station		$9.53
Income less shrinkage		11.73
Surplus over expense		9.15
Surplus in per cent. of investment		96.0

The Engineers recommended that party-line residence service should be given at the lowest possible rates, even at the cost of raising the business rates. It is suggested that the residence rates might be adjusted to yield 5% of the investment and the business rates for 7 or 8%. Measured party-line service is advocated as a means of eliminating frivolous use of the instruments which results in running up the operating and maintenance expenses. Excess calls would yield an additional income also. As an example of such a development the following schedule is shown:

FOUR-PARTY SERVICE (600 CALLS PER YEAR).		
General expense	$4.45	
Maintenance	3.37	
Operation	1.63	
		$9.45
Taxes, insurance, depreciation, etc.		7.21
Total		$16.66
Investment per station		$80.00
Income less shrinkage		20.79
Surplus over expense		4.13
Surplus in per cent. of investment		5.16

Rondout Pressure Tunnel of the Catskill Aqueduct, New York City.

By ALFRED DOUGLAS FLINN.* M. Am. Soc. C. E.

Between Ashokan Reservoir, in the Catskill Mts., and the northerly line of New York City, the 92-mile Catskill aqueduct is made up of four distinct types: 55 miles of cut-and-cover; 24 grade tunnels, aggregating 14 miles; 14 steel pipe siphons, totaling six miles; and seven pressure tunnels, amounting to 17 miles in length and requiring 29 shafts. The pressure tunnels are circular, about 14 ft. in diameter, and have been used for crossing deep and broad valleys where suitable rock exists. They are to be lined throughout with rich Portland cement concrete. Usually, a pressure tunnel has a downtake and an uptake shaft at its ends, and an intermediate drainage shaft; the longer tunnels have additional shafts for construction purposes, which are sealed at the completion of the tunnel. To April 15, 1911, about 15 miles had been excavated, including all the shafts, and concrete lining had been placed in three miles.

In geographical order, from north to south, the pressure tunnels, or inverted siphon tunnels, of the Catskill Aqueduct are Rondout, Wallkill, Moodna, Hudson, crossing beneath the valleys of streams of these names; Croton, under the new Croton Reservoir; Yonkers, in a ridge, passing beneath expensive real estate and avoiding cut-and-cover location with a large proportion of foundation embankments; and part of Van Cortlandt Siphon, extending from Hill View Reservoir to the city line. This type of aqueduct has also been adopted for the principal delivery conduit within the city limits, as far as the heart of the Borough of Brooklyn. The Rondout Siphon is the farthest advanced toward completion and is selected for description for that reason, because it is typical of all in most respects, and because it has several individual features of special interest. Only the crossing of the Hudson River exceeds it in depth, the maximum depth of the Rondout Siphon being 710 ft. and of the Hudson Siphon 1,150 ft. below the surface of the ground. The purpose to make all parts of the aqueduct as permanent, secure and free from need for repairs as possible was the controlling consideration in adopting pressure tunnels. Where they have been adopted the pressures exceed those believed to be conservatively safe for reinforced-concrete construction. They are estimated to be as cheap or cheaper than steel-pipe siphons, even when allowance is made for constructing the latter one pipe at a time, thus deferring part of the investment, and are more permanent than pipes even when the latter are lined with mortar and covered with concrete. Indeed, there are good reasons for expecting the pressure tunnels to prove the most enduring portions of the aqueduct.

Location of the Tunnel.

GENERAL SURVEYS.—In the surveys earnest efforts were made to reduce valley crossings of whatever type to a minimum in number, and secure the shortest length consistent with economy in the whole aqueduct. In the Catskill scheme, as first adopted, the aqueduct started from the extreme easterly end of Ashokan Reservoir. More detailed studies, as soon as time could be gotten for them, together with surveys and geological investigations, proved that a large sum of money could be saved, serious construction difficulties avoided and other advantages gained by starting the aqueduct at Brown's Station, near the middle of the length of the reservoir, at the main dams. Knowledge gained early of the valleys of Esopus and Rondout creeks especially indicated that crossings farther up-stream than those on the original line were greatly to be preferred. Triangulation, stadia and plane-table surveys were made of seven lines across Rondout valley and several lines were examined by borings. U. S. Geological Survey contour maps were a great assistance in making preliminary locations and have been a convenience ever since. A right-of-way 100 ft. wide was taken for the tunnel, with larger areas at the shafts for disposal of spoil. At the end shafts land was taken for access roads from the nearest highway. Bench levels based on the mean sea level datum at Sandy Hook of the U. S. Coast & Geodetic Survey were run and checked over the length of the aqueduct, from the Catskills to Suffolk County, east of Brooklyn. Dumpy levels were used almost exclusively for this work with satisfactory precision and material economy.

Geological examination of the Rondout Valley, on the line adopted for the tunnel, proved the existence of two buried gorges in the bed rock, several important faults, and twelve varieties of rock, counting the five formations of the Helderberg series of limestones. The bottoms of the gorges were found by drilling to be about 220 and 250 ft. below the surface, and are shown by the profile, Fig. 1, on which are also drawn the numerous borings, the shafts and rock formations. One of these gorges was not suspected before the drilling revealed it. No very unusual methods or apparatus were used in drilling—wash pipes, chopping bits and dynamite being employed to get the casings through bed rock, and diamond drills for cutting cores. Core drilling was done not merely to locate bed rock surface, but, owing to complexity of the geology, was extended to considerable depths to develop the various rock formations, and to locate contacts, faults and other geological structural features.

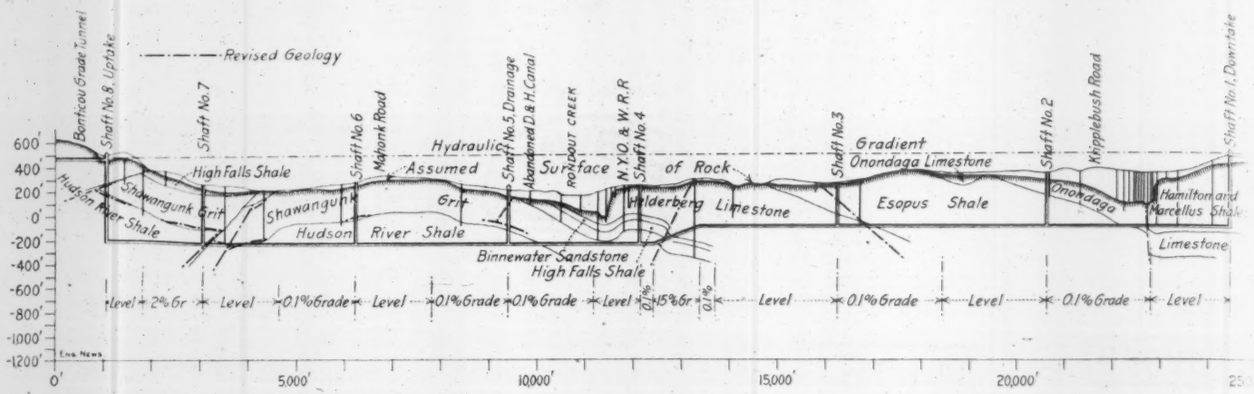


FIG. 1. PROFILE OF RONDOUT SIPHON OR PRESSURE TUNNEL, CATSKILL AQUEDUCT, NEW YORK CITY WATER-SUPPLY.

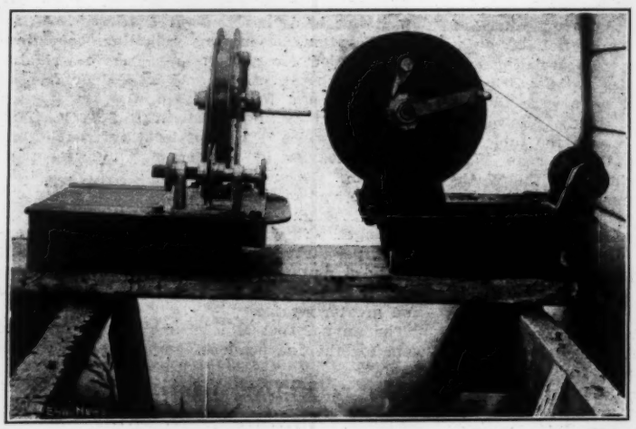


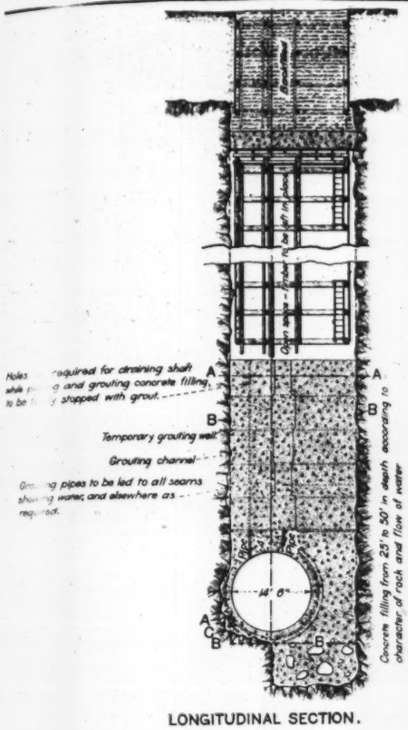
FIG. 2. WIRE REEL OR LINE-DROPPING APPARATUS USED IN ALINEMENT OF RONDOUT PRESSURE TUNNEL—FRONT AND SIDE VIEWS.

tures. This information was needed in order to select the best rock in which to place the tunnel and shafts, not alone to obtain the most favorable conditions for construction, but so far as feasible to place the tunnel in the most watertight rock, so as to minimize leakage after the aqueduct is in service. These geological problems were widely and very thoroughly studied by Prof. James F. Kemp and Dr. Charles P. Berkey, of Columbia University, and Prof. W. O. Crosby, of Massachusetts Institute of Technology, who also advised the engineers as to the placing of drill holes, the selection of shaft sites, and the depth of the tunnel.

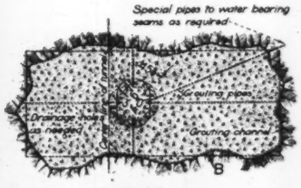
ALINEMENT.—As finally determined, the center line of Rondout tunnel is 23,608 ft. long, measured horizontally between centers of end shafts, and straight except for a slight deflection near the southerly end. It was fixed upon the ground by a concrete monument at each end and the middle; secondary monuments were set at the quarter points. From these principal monuments a pair of control monuments was set at each shaft from which to take the line into the tunnel. Two means were used for transferring the line from the surface to the bottoms of the shafts: (1) suspended wires; (2) shaft transit.

No. 8 steel piano wires were hung from special reels (Fig. 2) one on each side of the shaft. The shafts were of such dimensions as to permit base lines a little over 7 ft. long. To protect the wires from spattering water, air currents and injury, alinement boxes, 8 ins. sq. inside, made of boards, were fastened vertically to the shaft timbers on the center line of the tunnel. After brief experience the side of each box toward the center of the shaft was taken off as being unnecessary and interfering with rapid inspection of the wire from top to bottom, to make sure that it was not deflected by a projecting nail, splinter

*Department Engineer, Headquarters Department Board of Water Supply of the City of New York, 165 Broadway.


Temporary grouting wall
Grouting channel
Concrete filling from 25' to 50' in depth according to character of rock and flow of water
14' 6"

LONGITUDINAL SECTION.



SECTION A-A
(ENLARGED.)

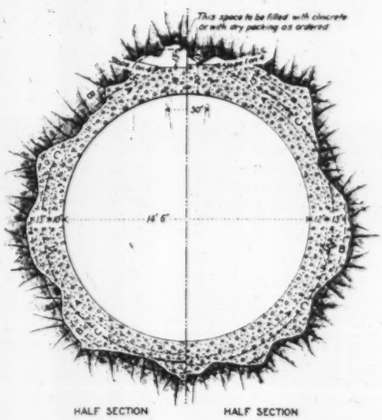
Fig. 3. Typical Sections of Rectangular Construction Shaft, Showing Concrete Closure with Means for Grouting on Catskill Aqueduct.

or other object, or by adhering to the wet sides of the box. Each reel was firmly secured over its alinement box, approximately on the center line, the wire unwound with a light weight on its lower end and brought exactly into line by the aid of a slow-motion screw, actuating a guide sheave over which the wire passed from the reel. Line was given by means of a transit set on the tunnel center line, 15 ft. from the shaft.

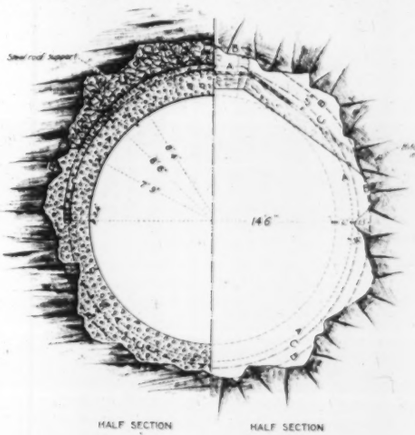
When the wire reached the shaft bottom a 20-lb. weight was substituted for the smaller one and the end of the wire with the weight placed in a large can of water. After the wires had become steady, the line was prolonged into the tunnel headings by transits in each tunnel, about 20 ft. from the nearer wire. Brass scales, 10 ins. long, graduated to hundredths of a foot for a length of 6 ins., and others 25 ins. long, graduated similarly for a length of 21 ins., and provided with verniers, were fastened in the tunnel roof approximately on line and transverse thereto; on these scales the transit line was read. As a check, the cans of water were removed and the weights allowed to swing freely in air, as pendulums. By means of convenient scales, on which the oscillations were read, points in the tunnel line were determined. Results proved that this pendulum method alone would have given sufficiently accurate alinement throughout the tunnel.

For the transit method a special instrument was built by C. L. Berger, the well-known instrument maker of Boston, according to ideas of Division Engineer James F. Sanborn. This transit had an auxiliary support for the telescope, cantilevered from the regular support and the plates, and when the telescope was placed in this auxiliary support it could be plunged so as to sight directly downwards into the shaft. With this transit a special illuminated sight-board was used; it was placed horizontally across the bottom of the shaft, and two marks near its ends were successively brought into the tunnel line as given by the transit. The operation was repeated several times, readings being taken on scales and verniers at the ends of the movable part of the sight-board bearing the line marks.

The shaft depths ranged from 374 to 710 ft., and the spacing from 2,000 to 4,400 ft. As the tunnel was excavated the brass roof scales mentioned above were set at intervals approximating 400 ft., the line being prolonged by setting an ordinary transit under the last-determined point and sighting to the one before. In the writer's opinion, great accuracy in alinement of water-works tunnels is not worth much expenditure of time or money. In the Rondout tunnel the lines actually met with variations of from ¾-in. to 8 ins. The errors in carrying through the levels did not exceed ½-in. Elevations were transferred from shaft tops to bottoms by using weighted steel tapes, making necessary corrections for weights, temperature and other conditions. Readers especially interested in details of tunnel alinement are referred to an article by Mr. Herbert M. Hale, Assistant Engineer, in the "Harvard Engineering Journal" for November, 1910.



TYPE A 14'-6" DIAMETER



TYPE C 14'-6" DIAMETER TYPE E 14'-6" DIAMETER

FIG. 4. STANDARD TYPES OF PRESSURE TUNNELS ON CATSKILL AQUEDUCT.

Construction Work.

SHAFT CONSTRUCTION.—For three shafts, Nos. 1, 2 and 5, where depths of 84, 60 and 50 ft.

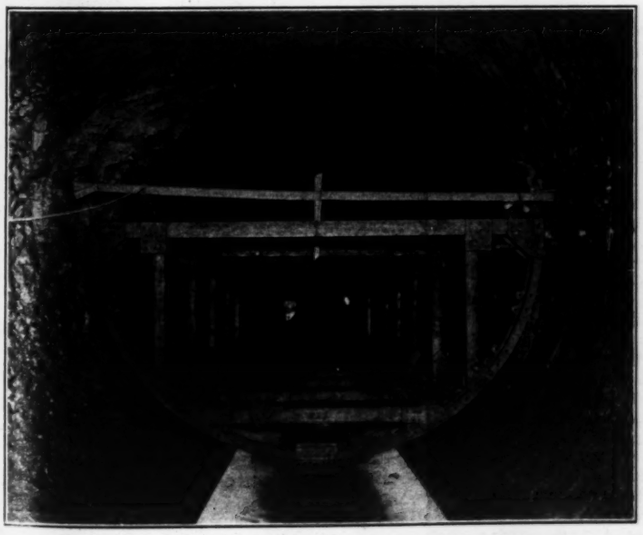


Fig. 5. Invert Built in Advance and Forms for Side Wall Ready for Concrete.

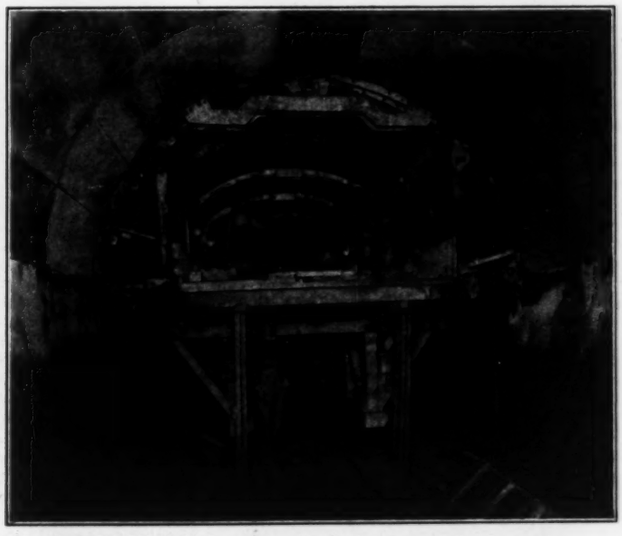


Fig. 6. Completed Lining with Arch Forms Still in Position.

FIGS. 5 AND 6. STEPS IN LINING PRESSURE TUNNEL, RONDOUT SIPHON, WITH CONCRETE, SHOWING STEEL FORMS.

(In Fig. 6 note ribs of form with plates removed to permit shoveling concrete for haunches of arch.)

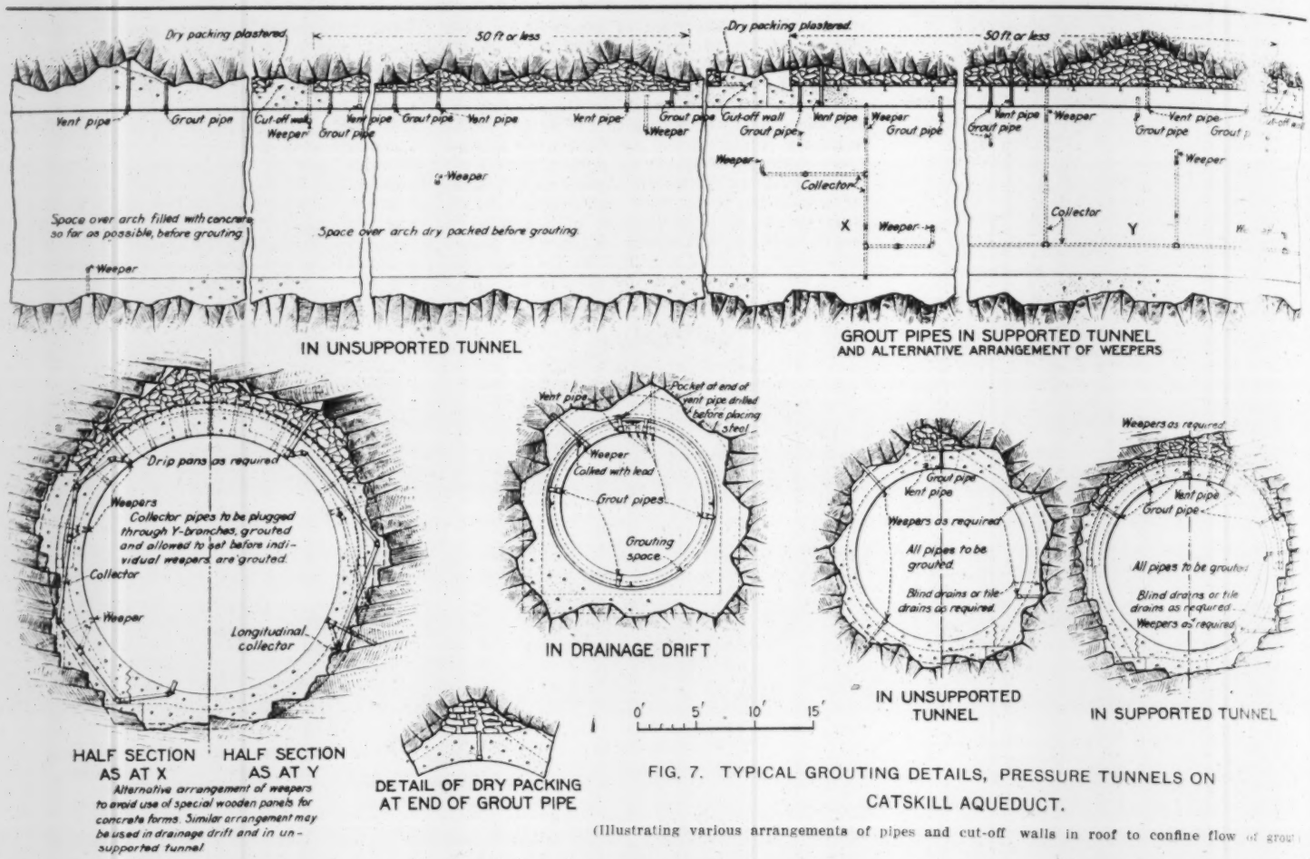

Dry packing plastered.
50 ft or less
Vent pipe
Grout pipe
Cut-off wall
Weeper
Space over arch filled with concrete so far as possible, before grouting.
Space over arch dry packed before grouting.
Collector
X
Y
IN UNSUPPORTED TUNNEL
GROUT PIPES IN SUPPORTED TUNNEL AND ALTERNATIVE ARRANGEMENT OF WEEPERS
Drip pans as required
Weepers
Collector pipes to be plugged through Y-branches, grouted and allowed to set before individual weepers are grouted.
Longitudinal collector
HALF SECTION AS AT X
HALF SECTION AS AT Y
Alternative arrangement of weepers to avoid use of special wooden panels for concrete forms. Similar arrangement may be used in drainage drift and in unsupported tunnel
Pocket at end of vent pipe drilled before placing steel
Coiled with lead
Grout pipes
Grouting space
IN DRAINAGE DRIFT
DETAIL OF DRY PACKING AT END OF GROUT PIPE
0' 5' 10' 15'
All pipes to be grouted.
Blind drains or tile drains as required.
IN UNSUPPORTED TUNNEL
IN SUPPORTED TUNNEL

FIG. 7. TYPICAL GROUTING DETAILS, PRESSURE TUNNELS ON CATSKILL AQUEDUCT.

(Illustrating various arrangements of pipes and cut-off walls in roof to confine flow of grout.)

of drift had to be passed, circular concrete caissons were adopted by the contractor, but proved unnecessary and disadvantageous, except at Shaft No. 2. At Shaft No. 2, a part of the material to be penetrated was an impalpable sand, which, when mixed with the ground water, flowed like thick cream. Indeed, the geologists described it as "glacial milk." At the other two shafts the drift was very compact and hard. Consequently, at Shaft No. 1 the caisson was sunk only 68 ft. At Shaft No. 5 great difficulty was experienced in making the caisson sink, and on one occasion it parted on a horizontal joint between days' work in the concrete; the lower 16 ft. dropped about 30 ins. from the upper part. With considerable difficulty the parts were brought together and the caisson carried down to rock. These caissons were 21 ft. inside diameter, 30 ins. thick, and reinforced with a small quantity of steel rods.

Fig. 3 shows the usual rectangular shaft and the provisions for sealing against water pressure at completion of the tunnel. Attention is called to the means for grouting. Shafts in the rock were sunk by the continuous method, using, commonly, 28 holes to each lift. First, eight sump holes were drilled, outlining a wedge-shaped piece of rock whose base was about one-third of the area of the bottom of the shaft. These holes were then loaded and fired as one shot. The muck was then removed as rapidly as feasible from one end of the shaft, and drilling begun and continued while the muck was being removed from the other end. The first bench was then shot and the other bench mucked. While removal of muck from the remainder of the shaft continued, the second bench was drilled and, when ready, shot. Two to three shots were used for the ten holes in each bench. The muck was then finally removed sufficiently to enable the next sump round to be drilled, and the process repeated. On the average, each lift required 1½ days, with a force of 2 drillers, 2 helpers and 10 muckers, working three shifts. The circular shafts are about 18 ft. in diameter, as excavated, and the rectangular shafts 10 by 22 ft.

SHAFT NO. 4.—As clearly foreshown by borings and the geological studies, Shaft No. 4 and portions of the tunnel between it and Shaft No. 3 were the most difficult to excavate, on account of the character of the rock formations, the large quantities of water, and the hydrogen sulphide gas with which this water was charged. Here the most troublesome formations of the valley had to be encountered; therefore, both Shaft No. 4 and the tunnel incline were so located as to pierce them in the shortest practicable lines. The profile, Fig. 1, shows the situation. At Shaft No. 4 only 6 ft. of earth overlay the rock, and the upper 80 ft. of the shaft were dry. Solution has created numerous caverns, of a great variety of shapes and sizes, in the Helderberg limestones. Some of the caverns are several feet in width, of considerable height, and extend for unexplored distances and at various angles to the tunnel; at depth they are filled with clay. The Helderberg series comprises five formations: Port Ewen, Beacraft, Scotland, Coeymans and Manlius, in order from top downwards. The Manlius is the chief source of the cement rock used in the manufacture of the "natural" cement which made Rosendale, only a few miles distant, famous. High Falls shale is made up of very thin strata, substantially horizontal, and is also intersected with seams. All these rocks are freely water bearing, as is, also, the Shawangunk grit through its many open fracture seams due to its extreme brittleness. Especially prolific in its yield of water was the Binnewater sandstone.

Consequently, for over 400 ft. Shaft No. 4 was sunk with great difficulty, the quantity of water pumped rising at times to nearly 900 gals. per min. during shaft sinking, and, as tunnel excavation progressed, increasing to approximately 2,000 gals. per min. as a maximum; for many months the flow has been 1,300 gals. per min. or more. Six times the shaft was drowned, water rising each time to less height—the first time within 40 ft. of the top and the last time to within about 80 ft. A simple air lift was the only successful apparatus for unwatering the shaft on such occasions. Owing to the increasing quantities of water, the sinking pumps became so numerous as to obstruct the shaft beyond endurance; therefore, a 17 × 24 × 10-ft. pump chamber was excavated at one side of the shaft at a depth of 300 ft. from the surface, with a 14,500-gal. sump. Here three Cameron horizontal steam pumps, of 1,050 gals. per min. aggregate capacity, were installed.

Water in drill holes, when confined in pipes, was repeatedly found to be under pressures of 85 to 95 lbs. per sq. in. Various means for coping with this inflow of water were tried. Collecting rings around the shaft were used to good effect to intercept water at higher levels and prevent its falling down the shaft, but grouting the rock through diamond-drill holes in advance of shaft sinking proved the only means which made real progress possible. On account of the hydrogen-sulphide gas, forced ventilation became necessary. Eighteen months were consumed in getting this shaft down to tunnel grade, the average progress being 28 ft. and the maximum 80 ft. per month. Fortunately, none of the shales encountered in this difficult stretch of shaft and tunnel were of the swelling varieties. The rocks were stable, for the most part, and very little support was found necessary. Much valuable detailed information concerning methods of sinking deep and difficult shafts was gathered by Designing Engineer Wiggin, on a trip to the mining regions of Michigan and Minnesota, late in 1908. Especially helpful were the statements of the experience of Mr. E. F. Bradt, who was engaged in sinking a deep and very difficult wet shaft for the Detroit Salt Co., near Detroit, Mich. He developed a method of grouting the rock in advance, so as to keep the water out of the shaft. An instructive, detailed account of this part of the work was prepared as a paper, entitled "Sinking a Wet Shaft," by Assistant Engineer John P. Hogan, Jr., Am. Soc. C. E. (see Proc. Am. Soc. C. E., March, 1911).

TUNNEL DRIVING.—Considering the purpose for which this tunnel was intended, it was desired to have the lining placed as solidly as possible against the rock. Hence, such timbering as is common in railroad tunnels could not be permitted. For rock requiring permanent sup-

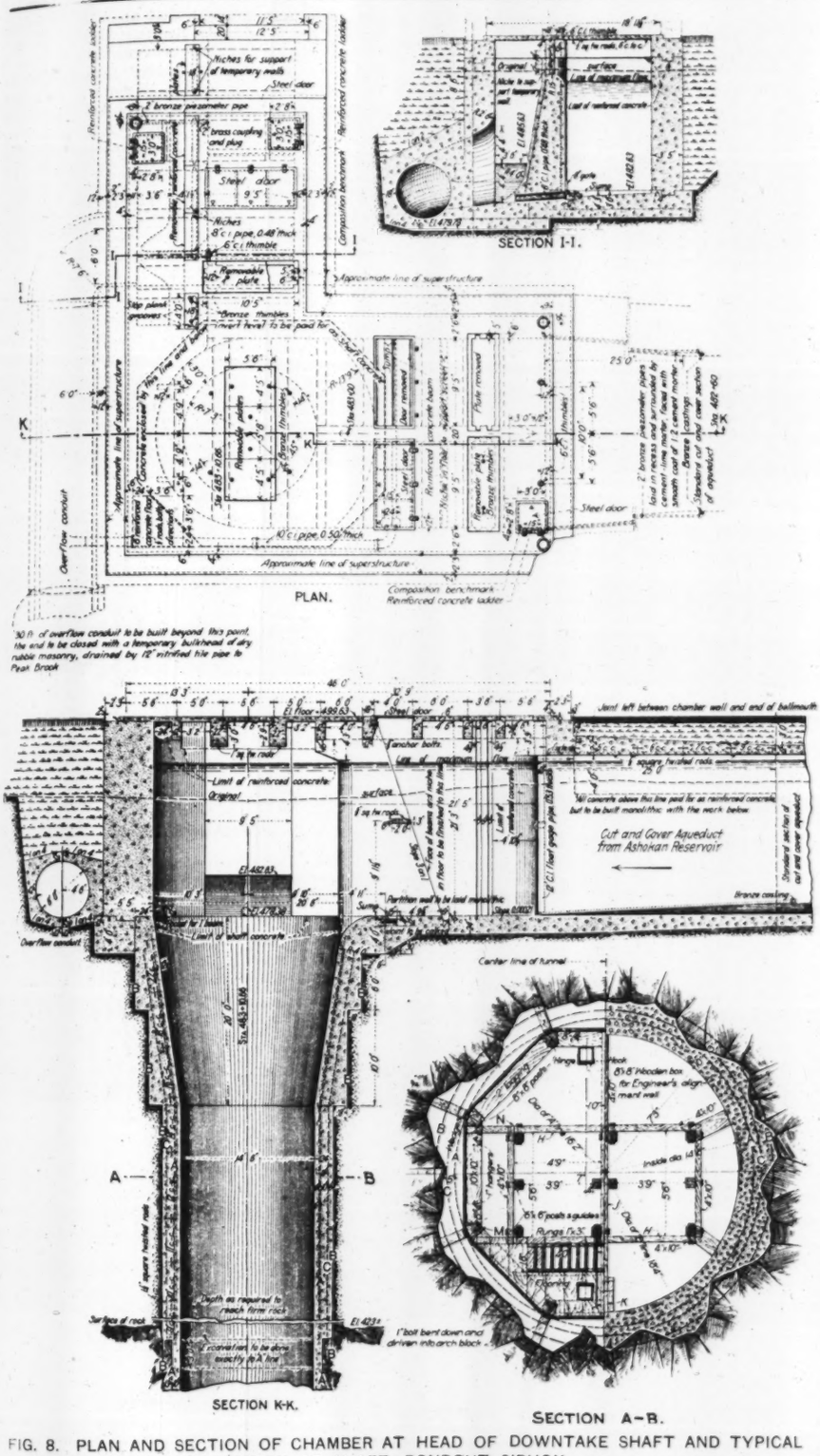


FIG. 8. PLAN AND SECTION OF CHAMBER AT HEAD OF DOWNTAKE SHAFT AND TYPICAL SECTION OF SHAFT, RONDOUT SIPHON.

port, several varieties of steel roof support were devised. Anticipating, however, that there might be considerable stretches of tunnel in which, although not safe to leave the rock unsupported while men were passing beneath, permanent support would be unnecessary, a type of temporary timbering was provided for and extensively used. But little steel roof support was needed. Temporary timbering is permitted to be set so as to encroach upon space within which permanent timbering or projecting rock is forbidden. Fig. 4 shows types of support. For the temporary timbering, caps ranged from 5 to 9 ft. in length, usually 10 × 10 ins. Such timbering has not been kept to line or exact position, but fitted roughly to the roof as the rock broke from place to place. Lagging was placed on the bents, and packing and wedging against the rock securely done. Before placing temporary timbers, the rock was thoroughly scaled, and as this timber has been removed, additional scaling has been done. So far no accident worthy the name has occurred with the removal of temporary timbering and the placing of concrete in the reaches of tunnel so supported. The tunnel has been driven by the usual American method of a top heading and bench, each being about half the diameter of the tunnel in height.

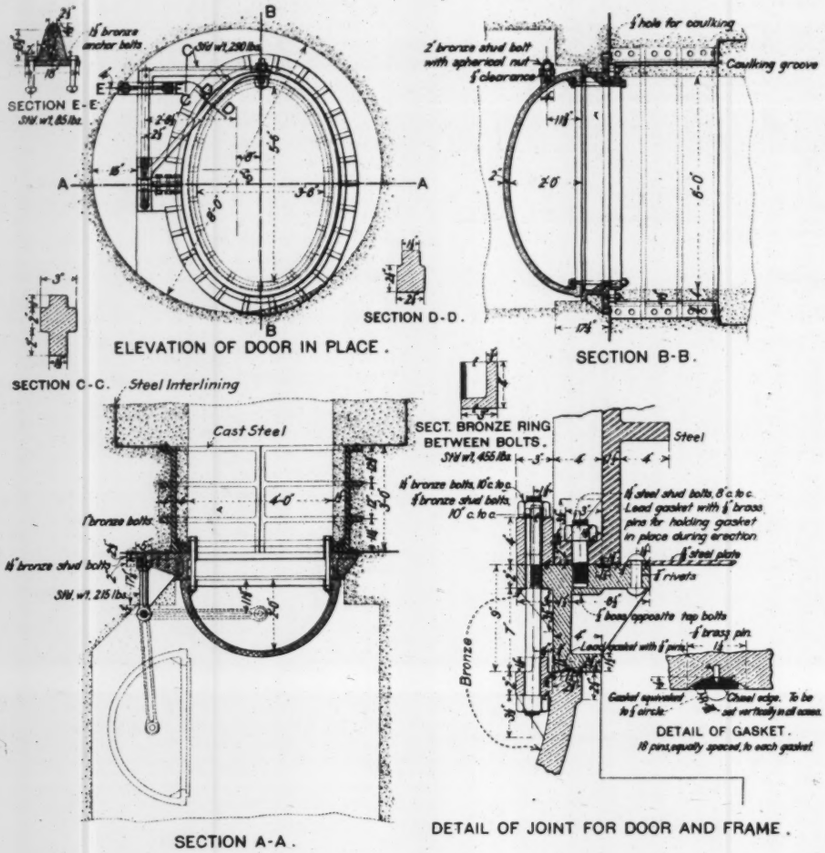
TUNNEL LINING AND GROUTING.—After being excavated the tunnel was trimmed to satisfy the requirements of the "A" and "C" lines of the standard cross-sections, wherever necessary, parts of the trimming being done concurrently with tunnel driving. As temporary roof support was removed in short stretches, additional scaling was done. Thus prepared, the successive portions of the tunnel were lined with concrete in three principal steps: First, the invert, shown in Fig. 5, was placed between longitudinal side boards, with the aid of guides and screeds; then the circular steel forms, shown in the same view, were set, and the concrete placed upon them to the springing line. These forms were built by the Blaw Collapsible Steel Centering Co., of Pittsburg, Pa. Later, these forms were inverted and used for the arch lining, as shown in Fig. 6. Keying of the arch was done in short longitudinal sections, working back from the forward end of the forms, the last short section of key form, with its fresh concrete, being jacked into place.

After the lining has attained an age of three months or more, grouting is done under pressure through pipes arranged as suggested in Fig. 7 and used in part for venting water from the rock. Great care is exercised to give the air opportunity to escape during grouting. An endeavor is made to fill not only small spaces between concrete and rock, or joints in the concrete and voids in the dry packing, wherever such packing was used, but also the crevices in the rock, so as to increase its impermeability, since it is the rock which is mainly relied upon for the water tightness of the tunnel. Lining has been placed wholly or partly in a large proportion of the length of the Rondout tunnel, but grouting has as yet been done in only a relatively small portion.

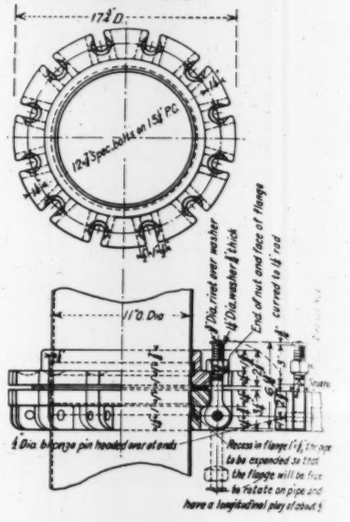
WATERWAY SHAFTS.—Waterway or end shafts are of the same diameter as the tunnel, and similarly lined. At the foot of each is a quarter bend of liberal radius, to reduce losses of head due to change in direction. In cross-section these shafts are like the drainage shaft, which is described in detail below, except that there is no tile interlining and the finished diameter is 6 ins. greater. At the head of each is a concrete chamber, with a bell-mouth and a transition section, forming the connection with the cut-and-cover aqueduct. At the downtake chamber provision is also made for the future aqueduct from the reservoirs to be built on the upper watershed of Rondout Creek, which will join the Catskill aqueduct here. Fig. 8 shows the arrangement of this chamber. The uptake chamber is similar, except the provision for the future aqueduct. In both are stop-plank grooves; also float gages, to show depths in the adjacent cut-and-cover aqueduct. In the downtake chamber is a guard rack, to keep heavy objects or men from falling into the shaft, and in the uptake chamber bronze guard rails, for safety of men working in the aqueduct when empty. At the downtake chamber is a safety overflow to prevent surcharge of the cut-and-cover aqueduct downstream from the siphon through improper adjustment of the flow in the Rondout and Catskill aqueducts at their respective reservoirs. Both end shafts afford access to the tunnel whenever the siphon is unwatered.

Construction Power Plant.

In order to get the earliest possible start at shaft sinking, a small temporary, steam-driven, compressed-air drilling and hoisting plant was installed at each shaft site. No time was lost, however, in planning and erecting an unusually complete and excellent central power plant of generous capacity. Compressed air was the medium chosen for transmission to the several shafts. A site was selected on the bank of Rondout Creek near the tunnel line and about one-half mile from the High Falls station of the Kingston branch of the New York, Ontario & Western R. R. In this situation abundant good water is at hand for steam making, condensing and cooling, and a short spur track, built by



the contractor, delivers coal at sufficient elevation to discharge into the tops of the bunkers without lifting. Being between Shafts Nos. 4 and 5, the power plant is near the middle of the tunnel. In the immediate vicinity are a machine shop, principal storehouses for cement and other supplies, a barn, a lumber yard and the contractor's main office. The machinery was all new and of high class. The compressors are two-stage, and the air is both inter-cooled and after-cooled, thus keeping practically moisture out of the pipe lines. An interior view of the power plant is shown by the front page engraving. Figures relating to this plant are tabulated on the opposite page:



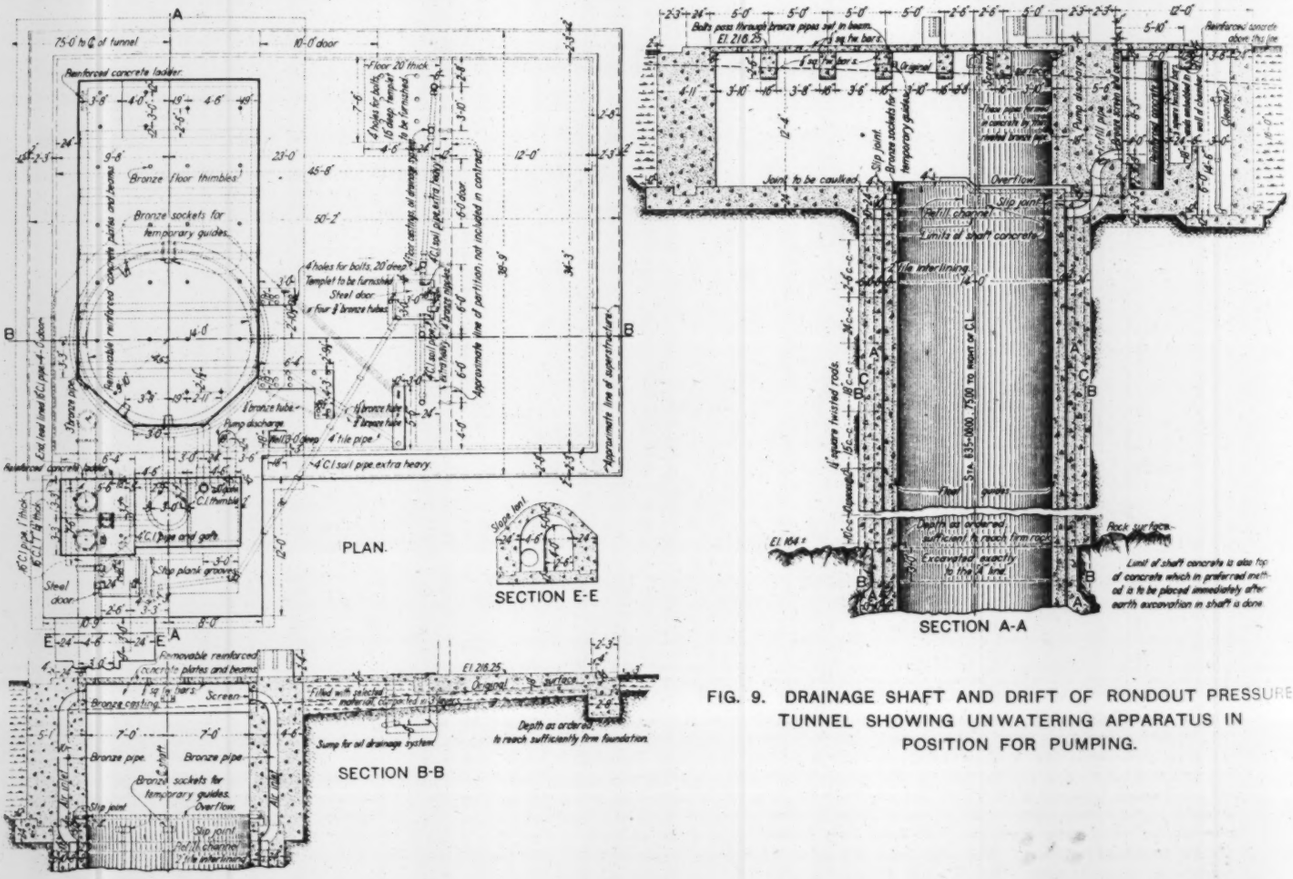
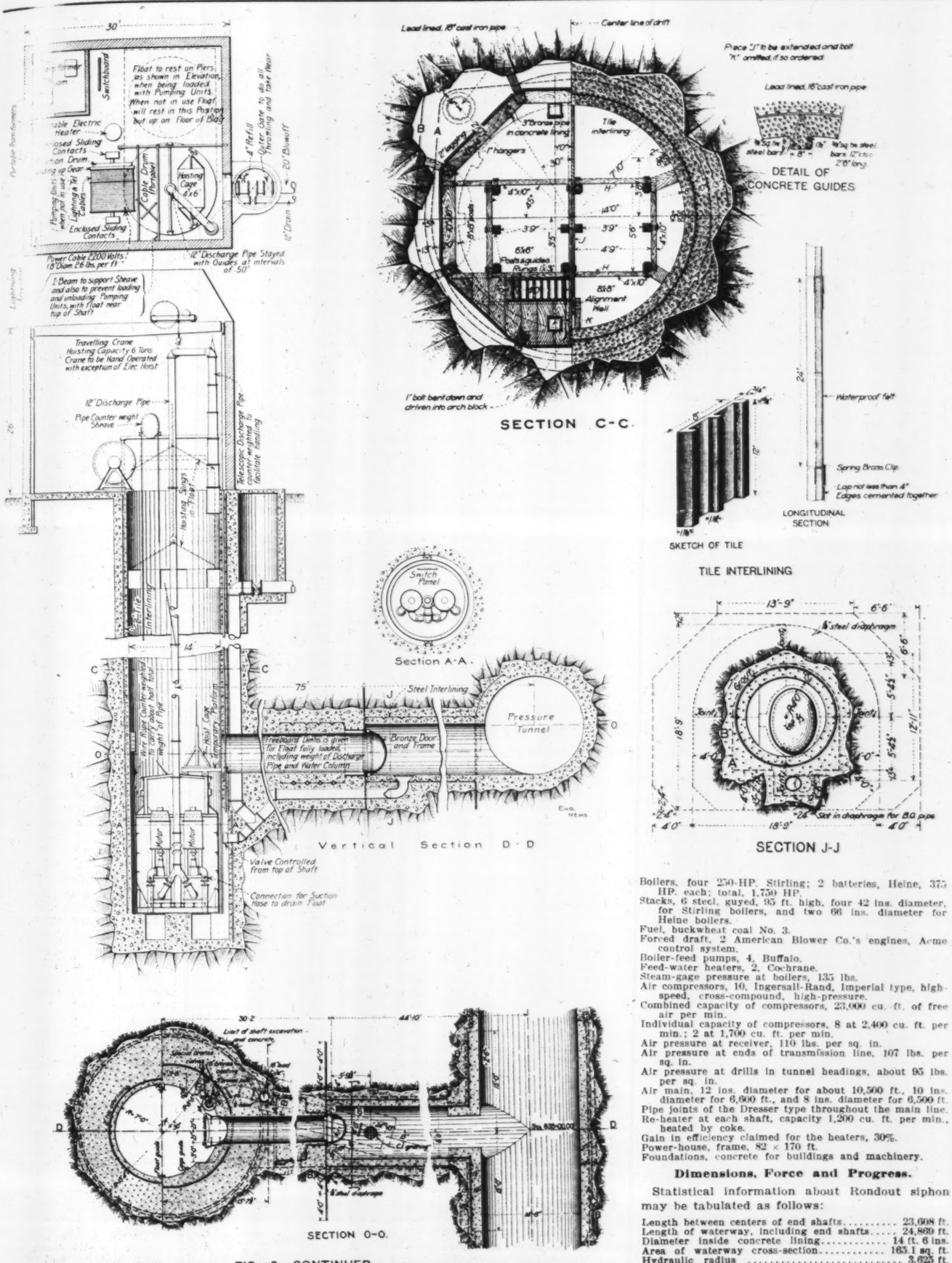


FIG. 9. DRAINAGE SHAFT AND DRIFT OF RONDOUT PRESSURE TUNNEL SHOWING UNWATERING APPARATUS IN POSITION FOR PUMPING.


Float to rest on Piers as shown in Elevation when being loaded with Pumping Units. When not in use Float will rest in this Position but up on Floor of Bldg.
Switchboard
Enclosed Sliding Contacts
Hoisting Cage 4'x6'
4" Pet Fill
Outer Gate to do all Throttling and take Hear
20" Blowoff
12" Drain
Power Cable 2200 Volts 1 8" Diam 2.6 lbs. per ft
12" Discharge Pipe Stayed with Guides at intervals of 50'
I Beam to support Sheave and also to prevent loading and unloading Pumping Units, with Float near top of Shaft
Travelling Crane Hoisting Capacity 6 Tons Crane to be Hand Operated with exception of Elec. Hoist
12" Discharge Pipe
Pipe Counter weight Sheave
Telescopic Discharge Pipe counter weighted to facilitate handling
Hoisting Slings in Float
Tile Interlining
Switch Panel
Section A-A
Steel Interlining
Pressure Tunnel
Freeboard Limits is given for Float fully loaded, including weight of Discharge Pipe and Water Column
Bronze Door and Frame
Vertical Section D-D
Valve Controlled from top of Shaft
Connection for Suction Hose to drain Float
Lead lined, 18" cast iron pipe
Center line of drift
Piece "J" to be extended and bolt "K" omitted, if so ordered
3" Bronze pipe in concrete lining
Tile interlining
I" hangers
Posts & guides Flange I&S
Alignment Wall
1" bolt bent down and driven into arch block
SECTION C-C
DETAIL OF CONCRETE GUIDES
Waterproof felt
Spring Brass Clip
Lap not less than 4" Edges cemented together
LONGITUDINAL SECTION
SKETCH OF TILE
TILE INTERLINING
Joint
Joint
Joint

Probable max. hydraulic capacity of siphon..	670 m.g.d.
Total loss of head in tunnel and waterway shafts, including .25-ft. at downtake chamber and at uptake	16 ft.
Average diameter of excavation	17 ft. 4 ins.
Average thickness of concrete lining	17 ins.
Number of shafts	8
Depths of shafts from surface of ground, in order from north to south: Downtake, 593 ft.; No. 2, 446 ft.; No. 3, 374 ft.; No. 4, 498 ft., drainage, 497 ft.; No. 6, 527 ft.; No. 7, 514 ft.; uptake, 710 ft.; total, 4,160 ft.; in earth, 310 ft.; in rock	3,850 ft.
Maximum in earth, Shaft No. 1	84 ft.
Size of five temporary rectangular construction shafts, outside of timbers	10 × 22 ft.
Inside of timbers	8 × 20 ft.
Shaft timbers: 10 × 10-in. wall plates; 6 × 8-in. buntons; 2-in. lagging.	
Shafts Nos. 1, 5, and 8 (downtake, drainage and uptake) are circular, diameters inside concrete lining	14 ft. 6-ins., 14 ft., 14 ft. 6 ins.
Minimum rock cover over tunnel	180 ft.
Minimum rock and earth cover—that is, minimum depth of tunnel below surface	330 ft.
Maximum internal pressure when tunnel is in service	310 lbs. per sq. in.
Maximum internal pressure in excess of ground water pressure, about	130 lbs. per sq. in.
Maximum external pressure from ground water when tunnel is empty	300 lbs. per sq. in.
Rock formations pierced by tunnel: Hamilton, High Falls, Esopus and Hudson River shales; Binnewater sandstone; Onondaga and Helderberg limestones; Shawangunk grit, a quartz conglomerate.	
Depth of tunnel below hydraulic gradient: 710 ± ft. for 12,000 ± ft.; and 560 ± ft. for 11,600 ± ft.	
Depth of tunnel below sea level: 100 ± ft. for 11,384 ft.; and 250 ± ft. for 11,260 ft.; the two levels are connected by 955 ft. of 15% incline.	
Average rate of sinking rectangular shafts (except No. 4) (Shafts 2, 3, 6, 7)	58 ft. per mo.
Average rate of sinking circular shafts (Shafts 1, 5, 8)	56 ft. per mo.
Maximum progress sinking shafts (No. 1, circular, in Hamilton shale)	138 ft. per mo.
Average rate of driving tunnel (except between Shafts Nos. 3 and 4)	185 ft. per mo.
Maximum progress driving tunnel (full section in Hudson River shale)	488½ ft. per mo.
Height of heading, about half diameter of tunnel.	
Drill holes in tunnel heading per round: 6 cut, 6 relief, 10 rim, total	22
Length of heading drill holes: cut 10 to 12 ft. Others, 8 to 10 ft.	
Holes in bench per round: 4 in each of 2 rows, spaced 4 ft. apart in row.	
Kind of drills: 3¼-in. Ingersoll-Rand, 4 in heading, on 2 vertical columns; 2 on bench, on tripods.	
Shaft cages, 68 × 94 ins., balanced (except Shaft No. 1)	2
Hoisting speed	400 ft. per min.
Kind of hoists: Lambert	14 × 16 ins.
Tunnel cars, steel side-dump, 40-cu. ft. Koppell; track, 30-in. gage, turnouts 1,000 ft. apart.	
Drilling force: Heading foreman; 6 drill men; 6 helpers; 1 nipper.	
Mucking force: Foreman, 8 shovelers, 4 barrow-men in heading; 6 shovelers, 2 drivers, water-boy, 2 mules, at bench.	
Number of hours per shift	8
Shifts per day: Driving tunnel, drill men, 2 (8 to 4.30, day and night); muckers, 3.	
Explosive: 60% dynamite, 175 to 200 lbs. per round.	
Total excavation from shafts and tunnel, solid measurement in place; shafts, 40,000 cu. yds.; tunnel, 260,000 cu yds.	300,000 cu. yds.
Average quantity of solid rock per linear foot of tunnel	10.0 cu. yds.
Total concrete, shafts and tunnel approx.	121,000 cu. yds.
Av. concrete per lin. ft. of tunnel lining	3.7 cu. yds.
(a) Rate of placing invert to Dec. 31, 1910	
Lin. ft. of tunnel, av.	1,700 ft. per mo.
Lin. ft. of tunnel, max.	5,733 ft. per mo.
(a) Rate of placing side walls, to Dec. 31, 1910:	
Lin. ft. of tunnel, av.	1,600 ft. per mo.
Lin. ft. of tunnel, max.	4,511 ft. per mo.
(a) Rate of placing arch to Dec. 31, 1910:	
Lin. ft. of tunnel, av.	1,760 ft. per mo.
Lin. ft. of tunnel, max.	2,957 ft. per mo.
Mixture of concrete, 1 part cement to 4 parts broken stone and 2 parts sand.	
Mixture of 1:1 grout: 1 bag (0.9 cu. ft.) cement, 95 lbs.; 1 bag (0.7 cu. ft.) sand, 75 lbs.; 1.21 cu. ft. water, 75.6 lbs.; total, 245.6 lbs.; water, 30%.	
Sand for grout, 100% through sieve having 100 openings per sq. in., 75% through 1,600 openings; obtained from a bank.	
Pressure used in grouting, 40 to 300 lbs. per sq. in.	
Kinds of cement: Alpha and Giant Portland in concrete; Giant in grout.	
Approximate average costs to city, per linear foot: Tunnel, $180; end shafts, $285 in rock, $350 in earth; drainage shaft, $335 in rock, $400 in earth, based on *contract prices; do not include engineering, real estate, nor Board's administrative expenses.	
Date of contract, June 12, 1908; amount, approximate	$6,290,000
Contractor, The T. A. Gillespie Co., New York City.	
Construction time allowed in contract	54 mos.
Percentage of work done April 1, 1911	78

(a) Averages are for total elapsed time from the beginning of the given operation. Work was in progress on the invert lining at two places simultaneously, at four places on the side walls, and four places on the arch. The maximum rates of placing concrete were made with about 60 lin. ft. of steel forms in use at each of 5 places for the side walls, and about 45 ft. of steel forms at each of 5 places for the arch.

*For canvass of bids, see Eng. News, June 4, 1908.

Permanent Unwatering Apparatus

Unwatering of pressure tunnels, for occasional cleaning and inspection and possibly more or less extensive repairs in the distant future, was deemed necessary. Owing to their depth below surface, the water can be removed only by pumping; and in order that the aqueduct might not be out of service too long, an attempt has been made to provide plant of as large capacity as could be put into a shaft of reasonable size. After prolonged study of bailing buckets and many other devices, motor-driven, vertical turbine pumps were chosen and the drainage shafts given a diameter of 14 ft. Many detail problems had to be solved which were attended with more than usual difficulty because of the high pressures to be dealt with and the magnitude of the structures.

Means for admitting water under control from the tunnel to the shaft during pumping, and convenient access from the shaft to the tunnel after unwatering, were necessary; but during the long periods the aqueduct would be uninterruptedly in service the drainage shaft must be securely closed and leakage prevented. With the shaft directly over the tunnel, the only feasible means of closing seemed to be a large metal cover, secured by bolts, anchored at great depth. For the combined Moodna-Hudson Siphon and the Croton Siphon, owing to the excessive depth and difficulty of the shafts, and other considerations, this arrangement was chosen as practically unavoidable, but for obvious reasons a different method was preferred. Consequently, for the remaining siphons, including the City Tunnel, the drainage shafts are offset about 75 ft. from the tunnel and connected by a drift of 8 ft. finished inside diameter. In each drainage drift, about 30 ft. from the center of the shaft, the size is reduced to a 4 × 6 ft. ellipse, and on the concrete shoulder thus formed a bronze door, or valve, of elliptical dome shape, is seated, closing in the direction of the pressure from the tunnel. Steel interlining in the concrete lining of the drift, and a steel diaphragm extending transversely into the rock in a carefully cut slot, are provided to cut off leakage along the drift and through the rock. Very careful and thorough grouting will be done throughout. A by-pass pipe with special valves is provided to conduct water from the tunnel side of the bronze door to the shaft. This pipe can be opened from the top of the shaft. Of course, the bronze door can be opened only when the tunnel is empty, and must be closed and securely bolted with its special gasket in place before the tunnel is filled.

In order that men might in the future enter the shaft with confidence and readiness, it must be as free as practicable from squirting leaks. It was believed to be highly improbable that any single masonry lining of such extent, under the pressures involved, could be made sufficiently impervious throughout. In the offset drainage shafts, including the Rondout, two linings of rich, dense concrete were therefore decided upon, separated by a layer of tiles with vertical ribs on one side. These tiles are to be placed with their ribs in line and against the face of the outer lining in such a way as to form continuous vertical channels from top to bottom of the shaft. The inner or smooth face of the tiles is to be covered with waterproofing (Hydrex felt or equivalent), applied in horizontal strips with all joints cemented by heating and pressing with electrical tools. After the outer concrete lining has attained sufficient strength, and before the tiles are placed, thorough grouting is to be done, as in the tunnel. On the inner lining are to be formed two sets of vertical concrete guides for purposes explained below. The shaft will probably stand full of water, except when pumped out. Fig. 9 shows the general arrangement and several details of the drainage shaft and drift.

The pumping outfit is not to be kept in the drainage shaft, but in a chamber with a permanent superstructure, over the shaft. A deep, cylindrical, steel float will contain the machinery when in operation. This float is 12 ft. 9 ins. in diameter and provided with a pair of steel guides to engage the concrete guides on the d[illegible] the shaft. The float is about 22½ ft. [illegible] supports a steel platform on which [illegible] can be landed. The float has a doub[illegible] tight bottom containing substantial g[illegible] support the machinery. The upper pa[illegible] float is provided with louvres for ve[illegible] It is the intention to provide a float [illegible] drainage shaft, but to transport the m[illegible] from place to place as needed.

The pumping outfit consists, in the [illegible] two 4-stage vertical turbine pumps, de[illegible] the Board along established lines, of [illegible] gals. daily capacity each against hea[illegible] 600 ft., including friction; two 450-H[illegible] volt, squirrel-cage induction motors [illegible] connected to the pumps, running at [illegible] about 1,800 r.p.m.; three 250-KW. oil[illegible] and oil-cooled transformers, and disch[illegible] 10 ins. in diameter, in 20-ft. sections. [illegible] tor consisting of a cage and hoist is p[illegible] getting up and down from the flo[illegible] pumping, as it will require several day[illegible] out any siphon. This elevator will al[illegible] ful for men and materials during clean[illegible] pairs, and is arranged for carrying a [illegible] nel car. The shaft extends below the [illegible] a sump, of such depth that the work[illegible] form on top of the float will be at [illegible] vation. The float will be connected [illegible] surface by telephone, and provided wit[illegible] lights, a small blower for ventilation, and the necessary controlling devices for all operations. Certain operations, such as the starting and stopping of the motors, can also be controlled from the head of the shaft. Ordinarily, an attendant will be in the float while the machinery is in operation.

The pump-discharge pipe rises vertically in the center of the shaft and is steadied by structural steel supports about 20 ft. apart, traveling on the same concrete guides in the shaft as the float. As the float sinks, attendants at the top of the shaft will add lengths of pipe. The pipe is lap-welded and has wrought-steel flanges equipped with hinged bolts which can be quickly tightened. The nuts are prevented from being turned off the bolts by peening a washer on the end of each bolt. Adjustment in the length of the discharge piping between the additions of pipe sections, is accomplished automatically by a telescoping U-shaped outlet pipe. The various electrical connections to the float are combined into a cable, which is paid out from a reel mounted at the head of the shaft and equipped with collector rings on the end of the reel journal. A contract for this novel pumping outfit for the Rondout siphon was recently awarded to the D'Olier Engineering Co., of Philadelphia. Its general arrangement and some details are shown in Fig. 9. When the tunnel is to be emptied the machinery will be installed, with the aid of a traveling crane, in the float, while the latter is in a well in the chamber. After the outfit is in readiness, the float will be moved over the shaft, properly centered, and the connections made of the discharge piping and electric cable.

A lead-lined iron pipe, 16 ins. in diameter, extends from bottom to top of the drainage shaft, providing means for blowing off the water in the end shafts above the level of the top of the drainage shaft, and for refilling the shaft so as to bring the float back to the surface. Considerable difficulty was experienced in manufacturing this pipe and it has not proved wholly satisfactory. The difficulties have, however, been sufficiently mastered so that the purpose can be safely served. In the light of this experience, bronze pipe would be adopted for similar work in the future. Shaft No. 5 was chosen as the drainage shaft for Rondout Siphon, being in the deep part of the siphon and close to the creek where the water could be conveniently discharged.

Much information about the design and construction is given so clearly by the illustrations that it is not necessary to translate it into words. The downtake, uptake and drainage shaft each is to have a permanent masonry superstructure erected over its chamber, from

pleasing designs by the Board's Staff Architect, Mr. H. Lincoln Rogers. The Board's Consulting Landscape Engineer, Mr. Charles W. Leavitt, Jr., has given attention to the surroundings of these buildings, and has also advised about the general arrangement and surface treatment of the spoil piles at the shafts, so as to prevent their remaining as monumental eyesores for untold years after the completion of the aqueduct. But little expense is necessitated by this attention to the esthetic side of the work, the chief requirements being forethought and definite, well-considered plans for guidance in placing the excavated materials without rehandling, excepting small quantities.

Messrs. Charles Strauss, Charles N. Chadwick and John F. Galvin are now the Commissioners of the Board of Water Supply, charged with the execution of projects for additional water supply for New York City. Mr. J. Waldo Smith is Chief Engineer, and Mr. Merritt H. Smith, Deputy Chief Engineer; and Messrs. John R. Freeman, William H. Burr, Frederic P. Stearns and Alfred Noble are Consulting Engineers. Mr. Robert Ridgway is the engineer in charge of the Northern Aqueduct Department, in which the principal deep pressure tunnels are situated. From the survey period to April 1, 1911, Mr. Lazarus White was Division Engineer of the Esopus Division, embracing the Rondout Pressure tunnel; at the date mentioned he was transferred to the City Aqueduct Department, leaving his former deputy, Assisstant Engineer John P. Hogan, in charge. The contract, the designs and many of the preliminary studies were prepared by Headquarters department, Mr. Thomas H. Wiggin, Designing Engineer, under the supervision of the writer. Mr. Robert Swan is Vice President and General Manager, and Mr. R. J. Gillespie, General Superintendent, in control of operations for the contractor. Shaft and tunnel lining and concreting are in progress, and are expected to continue during the summer and fall.

WATER FILTRATION FOR BALTIMORE, MD., and, until a plant can be built, treatment "by chlorine [hypochlorite?] or other improved chemical method," has just been recommended by a grand jury.

HOW AN AUTOMOBILE TIRE DESTROYS A MACADAM ROAD.—At last the palpable fallacy, which seems to have been so plausible as to secure wide acceptance even among motorists—the fallacy of the suction of the tire on the road—is beginning to give way before a much more reasonable theory to explain the effect of a pneumatic tire in extracting the fine loose dusty material with which it used to be customary to bind together the granite nodules which form a good macadam road. Today it is seen that the rubber of the tire is stretched as it rolls, and that on rising from the ground it reverts rapidly to its unstretched condition, giving a slight backward "flick" to the dusty binder which had become imbedded in the tread during its brief moment of forcible contact with the road. This flick is additional to the kick given by the driven wheels when more power is transmitted through them than the adhesion between tire and road warrants. The flick will certainly pick out and throw away fine binding dust, raising it an inch or two above the road. This is the explanation of that which has been called the suction of the tire. The fall of pressure caused by the car in its wake owing to its bad "lines" (from an aeronautical point of view) is a very slight one, but covers a large volume of air, and it is this quasi-vacuous space which is refilled by eddying currents flowing in to restore the equilibrium of atmospheric pressure which picks up and raises to a great height the dust which has been loosened by the flick and kick of the tire.—"London Times" Engineering Supplement, May 30. See also Engineering News of July 8, 1909, p. 47.

The Locomotives Exhibited at the Brussels Exhibition, 1910.

The railway exhibits of the International Exhibition at Brussels (Belgium) last year were very extensive, and although they related mainly to European railways some notes of the locomotives will be of interest as indicating some of the modern tendencies in foreign locomotive design.

These locomotives have been described very fully by Mr. M. A. Schubert (of the Motive Power Department of the Northern Ry. of France) in a series of articles in the "Revue Generale des Chemins de Fer"; from these articles we take the following information as to the special features of the exhibit.

The exhibit included 56 locomotives, 15 motor cars, 37 passenger cars, 2 baggage cars and 37 freight cars. Of the locomotives, 31 were built in Belgium, 14 in Germany, 9 in France and 2 in Italy. Further, 20 of them were for secondary, local and industrial railways. Most of these were of narrow gage. All the engines were for European railways, except that some of the "secondary" engines were for Brazil and East Africa. Classified by wheel arrangements, the locomotives were as shown in Table I.

TABLE I.—LOCOMOTIVES AT THE BRUSSELS EXHIBITION (1910).

Trunk line railways.				Secondary railways.	
Class.	No.	Class.	No.	Class.	No.
2-4-0	1	4-6-0	11	0-4-0	6
4-4-2	3	4-6-2	7	0-6-0	11
4-4-4	1	0-8-0	3	2-8-0	1
0-6-0	1	4-8-0	1	4-8-0	1
2-6-0	1	0-10-0	2	0-6-6-0 Mallet	1
		1-10-0	5		

Of the 36 main line standard gage engines, 12 were four-cylinder compounds, and 27 (including five of the compounds) were equipped with superheaters. The superheaters were all of the Schmidt type, except that one engine of the Eastern Ry., of France, had a helicoidal superheater designed on this railway. Of the 24 simple engines, it is remarkable that 14 had four cylinders; seven had two outside cylinders and three had two inside cylinders. The total weight ranged from 52 to 104 tons, with 52 and 88 tons respectively on the driving wheels. The lightest engine was of the 0-6-0 class, while four 104-ton engines were of the 2-10-0 class (Belgium). Only three of the main line engines were tank engines. Of the tenders, one had four wheels (but was attached to a French 2-10-0 engine), 22 had six wheels, and 10 had eight wheels. In some of the French six-wheel tenders, the axles were not spaced equally, but had one at the front end and the others (as close together as possible) at the rear end.

Four-Cylinder Simple Locomotives.

While three and four-cylinder simple engines have been used experimentally or for special service in this country and in Europe, the Belgian State Railways have the distinction of using large numbers of engines of this type in regular service. There were no less than 14 of these engines at the exhibition, all except one being for the above railway system but built by various firms. The other one was for the Prussian State Railways. The Belgian engines were of three classes (4-6-0, 4-6-2 and 2-10-0), and their principal dimensions are given in Table II.* Mr. Schubert states that this type of engine was adopted by the Belgian engineers to meet certain conditions: the lines are relatively short, the stops are numerous and the trains are heavy, while the character of the enginemen and firemen is such as to necessitate the use of engines which are strong, simple and easy to operate. The 4-6-0 engines† are to operate on lines of easy grades. The 4-6-2 engines are for lines having irregular profile and long grades of 1.6%. The inside cylinders (inclined) are placed far enough forward to drive the first driving axle; the outside cylinders are placed a little farther back and drive the second axle. The 2-10-0 engines are for handling very heavy freight trains on lines of easy grade, and each engine will take the place of two ordinary engines. The springs of the four rear driving axles are equalized, and those of the first driving axle are equalized with the truck. In fact the load on these two front axles is distributed in much the same way as on a truck; the load is carried on a spherical bearing supported by frames which rest on springs over both pairs of axle boxes, thus increasing the weight available for adhesion. This arrangement was devised by one of the engineers, Mr. Flamme. The lateral movement or play of the axles is 5.4 ins. (to each side) for the truck axle, 1.8 ins. for the first driving axle and 1.2 ins. for the rear driving axle. The Westinghouse brake is applied to all the 12 wheels. One of these engines has hauled a train of 443 tons on a line having grades of 1½ to 2½%, and on the latter long grade it increased its speed from 9½ to 13 m. p. h. The standard train load previously was 400 tons for two engines. On the easier part of this line (grades up to 1%) it has hauled a train of 650 tons.

Other Types of Locomotives.

The 4-4-4 engine was a fast passenger engine for the Northern Ry. of France. It had a long firebox behind the driving axles and the load at this point was too great for a single axle. This firebox was built up of water tubes. Both trucks had 36-in. wheels. Each axle of this trailing truck carried over 11 tons, while the other axle loads were 17.3 tons for the drivers and 10 tons for the leading truck. A similar arrangement has been applied to two engines of the 4-6-4 class, built to haul trains of 400 tons at 66 m. p. h. on grades of 0.5%. For trains of such weight the increasing tendency in Continental practice is to use engines with six coupled axles. The diameter of driving wheels on the four-coupled fast passenger engines was from 6 ft. 6 ins. to 6 ft. 11 ins.; on the six-coupled engines for similar service the largest diameter was 6 ft. 10 ins. With the increasing weight of freight trains, there is a tendency to use engines with five driving axles, and having a pony truck or radial axle instead of a four-wheel truck. All but two of the engines with four and five coupled axles were for freight service, and their driving wheels ranged from 49½ to 60 ins.

*Some notes of the locomotives at the exhibition at Liege (Belgium) in 1905 were published in our issue of Aug. 23, 1906.

†The 4-6-0 four-cylinder simple engines of the Belgian State Railways were described in our issue of Aug. 23, 1906.

TABLE II.—DIMENSIONS OF REPRESENTATIVE LOCOMOTIVES AT THE BRUSSELS EXHIBITION, 1910.

Railway	Belgian State.			Northern (France).	Prussian State.	Bavarian State.	Paris, Lyons & Med.	Italian State.
Class (C. = Comp.) (S = Simple)	(S) 4-6-0	(S) 4-6-2	(S) 2-10-0	(C) 4-4-4	(S) 4-6-0	(C) 4-6-2	(C) 4-8-0	(C) 0-10-0
Cylinders, h. p., ins.	(4) 17.8 × 25.6	(4) 20 × 26.4	(4) 20 × 26.4	(2) 15.6 × 25.6	(4) 17.2 × 25.2	(2) 17 × 24.4	(2) 15.2 × 26	(2) 15.0 × 26
Cylinders, l. p., ins.	.....	.....	.....	(2) 22.4 × 25.6	.....	(2) 26 × 26.8	(2) 24.0 × 26	(2) 24.4 × 26
Ratio of vol. of cyls.	.....	.....	.....	2.71	.....	2.33	2.49	2.64
Driving wheels	79¼ ins.	79¼ ins.	58 ins.	81 ins.	79¼ ins.	75 ins.	60 ins.	54 ins.
Wheelbase, driving	13.9 ft.	13.45 ft.	24.30 ft.	7 ft.	7.5 ft.	13.2 ft.	18.0 ft.	19.68 ft.
Wheelbase, engine	28.5 ft.	37.47 ft.	33.17 ft.	32.67 ft.	30.6 ft.	37.3 ft.	30.3 ft.	19.68 ft.
Weight, on drivers, tons	53	57	88	35	50	48	60	75
Weight, engine, tons	81	102	104	77	77	86	75	75
Boiler, diameter	5.40 ft.	5.9 ft.	5.9 ft.	5.0 ft.	5.2 ft.	5.5 ft.	5.0 ft.	5.2 ft.
Boiler, height to center	9.23 ft.	9.35 ft.	9.5 ft.	9.2 ft.	9.2 ft.	9.3 ft.	8.5 ft.	9.2 ft.
Firebox, at grate, ft.	10 × 3.3	8.2 × 6.56	9.5 × 5.7	7.2 × 5.3	8.53 × 3.6	6.8 × 7.0	10 × 3.3	7.1 × 5.2
Boiler pressure, lbs.	186	210	210	270	180	225	240	240
Tubes; length, ft.	13.12	16.4	16.4	14.27	16	17.2	14	17
Heat. surface: Tubes, sq. ft.	1,494	2,367	2,367	916	1,514	2,193	2,489	2,416
Firebox, sq. ft.	177	215	204	118	146	157	171	124
Total, sq. ft.	1,671	2,582	2,571	1,034	1,660	2,350	2,660	2,540
Superheat. surface, sq. ft.	407	667	667	None	569	538	None	None
Grate area, sq. ft.	34.2	54	55	38	28	48.4	33	37.6
Tender, class	6-wheel	8-wheel	6-wheel	6-wheel	8-wheel	8-wheel	6-wheel	6-wheel
Weight, loaded, tons	48	53	53½	42	50	55	40	26
Coal, tons	6	7	7	6	5	7½	5	4 (on engine)
Water, tons	20	24	24	19	21	26	16	13
Length over engine and tender	58.4 ft.	70.2 ft.	66 ft.	64 ft.	63.5 ft.	70 ft.	64 ft.	67.4 ft.

diameter. The exceptions noted were engines with 5-ft. driving wheels for passenger service on mountain divisions of the Paris, Lyons & Mediterranean Ry. (4-8-0) and the Paris & Orleans Ry. (2-10-0).

The four-cylinder arrangement for the 4-6-0 simple engine of the Prusian State Railways was adopted to ensure proper balance of the moving parts, as the engine is designed to handle trains at 62 m. p. h. The 4-6-2 engine for the Bavarian State Railways is a four-cylinder compound, with four piston valves and the Schmidt superheater. The cylinders are all in line under the smokebox (the inside high-pressure cylinders being inclined), and all drive the second driving axle. The firebox is wide, entirely above the bar frames; the back head is inclined and has two firedoors. The ashpan is in three sections, one between and the other outside of the frames.

The 0-10-0 engine for the Italian State Railways is a four-cylinder compound, but operates practically as a double two-cylinder compound, each side having a high-pressure and a low-pressure cylinder served by a single piston valve. In this way each side of the engine is balanced. The cylinders are all in line, with the inside cylinders inclined. Engines of this class work trains of 200 to 270 tons on a line having grades of 1 to 2½%, and curves of 6°. Coal is carried in a rear bunker on the engine frames. The tender has a cylindrical tank and a baggage compartment, thus avoiding the use of an extra baggage car.

The 2-10-0 locomotive for the Paris & Orleans Ry. was of a type designed to handle passenger trains of 370 tons on 2% grades at speeds of 25 to 28 m. p. h., and freight trains of 1,200 tons on 0.5% grades at 28 m. p. h.

General Features of the Locomotives.

The comparatively small number of compounds is taken to indicate that the compound system is not increasing in favor, and France alone continues to adopt this system extensively. Germany, which built compounds (usually of the two-cylinder type) about 1900, seems to have reverted to the simple engine. Belgium, which built several four-cylinder compounds about 1905, has now definitely adopted a four-cylinder simple type for heavy service, for reasons noted above.

The ratio of volume of high-pressure and low-pressure cylinders was from 2.26 to 2.82, except that in one engine, mentioned below, it was as low as 1.38. In two of the four-cylinder compounds, the length of stroke was not uniform. In the 4-6-2 engine for the Bavarian State Railways the high and low-pressure cylinders were respectively 17 × 24.4 ins. and 26 × 26.8 ins. (ratio of volume 2.33); in a 2-10-0 engine of the Paris & Orleans Ry. they were 22.4 × 24.8 ins. and 26.4 × 28 ins. (ratio 1.38). Seven of the compounds had the high-pressure cylinders outside, four had them on the inside, and one had the two high-pressure cylinders on one side and two low-pressure cylinders on the other side. The greater weight of the low-pressure cylinders and motion makes it desirable to place them between the frames, but with very large cylinders this is impracticable. Most of the engines with outside low-pressure cylinders were for slow speed service, and one of them had these cylinders of 26 ins. diameter. Some of the fast engines with inside low-pressure cylinders had the frames bent or offset so as to admit of this arrangement. Of the 12 engines, nine had the high and low-pressure cylinders driving two separate axles, while three had all the cylinders driving one axle. All the compounds were equipped with starting valves for admitting live steam to the low-pressure cylinders. In the French engines and one of the German engines, the superheaters were applied to compound engines; the others having superheaters were simple engines.

The largest diameter of boiler was 6 ft., and the greatest length of tubes 20 ft. 6 ins. The Serve ribbed tubes were employed in only a few engines (French); the plain tubes were generally of steel, but the Belgian engines had brass tubes with steel ferrules. An objection to the Serve tubes is that they cause trouble with the tube sheets when the length exceeds 14 ft. 9 ins. For this reason, some of the French railways have abandoned their use, in spite of their advantages in regard to the generation of steam. While brass tubes have been largely abandoned, the Belgian State Rys. continue their use, but in order to compensate for the difference in expansion between the tubes and the boiler barrel, the tubes are given a slight camber. The superheater tubes in the same boiler, however, are of steel and without camber. A locomotive of the Prussian State Railways had segmental cylindrical shields placed across the smokebox to shut off the current of gas through the superheater tubes when the throttle is closed.

The boiler pressures of the simple engines were in general about 170 lbs., but as high as 200 lbs. on the Belgian engines. For the compounds, the pressures were from 200 to 227 lbs., except that a French locomotive with water-tube firebox carried 255 lbs. (Engineering News, Sept. 22, 1910). On this engine (and another French engine carrying 227 lbs.) the boiler plates are ¾-in. thick.

The grate area of a number of the engines exceeded 33 sq. ft., and the maximum was 55 sq. ft. in some of the Belgian engines of the 4-6-2 class. Mr. Schubert states that while this area has been exceeded in American engines it approaches the limit of size of firebox which can be fired properly by one man, since it requires the firing of about 4,400 lbs. of coal per hour. On these particular Belgian engines the fuel consists of coal briquettes, which are fired without being broken. For large grate area, it was necessary to abandon the ordinary firebox, placed between the frames. Where the size of driving wheels does not admit of placing the wide firebox above them, it has been necessary to add a trailing axle to support the weight; in two French engines of the 4-6-2 class, the forward part is between the frames while the rear portion is much wider (3.2 ft. and 6.2 ft.); the length is 9 ft. 6 ins. This arrangement enables the wheelbase to be kept short. In some of the engines, a deep firebox 6 ft. 6 ins. wide is used, being placed between the trailing axle and the rear driving axle; this necessitates spacing these axles 12 to 13 ft. apart.

The staybolts were generally of copper, but some of the French engines had staybolts of manganese-bronze for part of the firebox. The strength of the latter (when heated) is greater, but the heads are reduced more rapidly, especially in the lower rows where the heads are subject to direct contact with the flames. For this reason the bronze staybolts are confined to the upper part of the firebox. The boilers of a 4-4-2 engine for the Prussian State Railways had some of the staybolts fitted to sleeves or sockets inserted in the outside plates; a nut is screwed upon the head of the staybolt (bearing upon the end of the socket) and a cap is screwed upon the socket to cover the nut. These staybolts are of manganese bronze. They are used for the two end rows of vertical crown stays (connecting a flat crown sheet to a circular outer sheet) and for the four top rows in the side sheets.

The firedoors were of various types, some sliding, others opening inward or outward. Most of the German and some of the Belgian engines had the Marcotti door, which opens inward and is hung on horizontal hinges at the top. Two jets of steam are directed into the firebox just above the door, being directed downward to the level of the brick arch, so as to form a curtain of steam which, in combination with the air admitted at the door, will ensure complete combustion and prevent the emission of smoke when firing. The door was formerly made to be closed automatically by a dashpot or cataract, but this arrangement is now omitted. The same apparatus includes an automatic attachment for admitting steam to the blower when the throttle is closed. The use of the Marcotti system has been shown to effect an economy of 5 to 7% in fuel consumption. As a result of extended tests, the system was applied to 60 engines for operating local trains in Berlin, so that coke might be replaced by a cheaper fuel.

Most of the compound and simple engines with superheaters had four piston valves, [illegible] one of them had slide valves for the low-pressure cylinders. Of the compounds using saturated steam, some had the above arrangements, one had the Vauclain system with only two piston valves for the four cylinders, and one had the Lentz poppet valves on the high-pressure and piston valves on the low pressure cylinder. All the simple engines using saturated steam had plain slide valves. The Walschaerts valve gear was used on the French and Belgian engines, and the Heusinger gear on the German engines.

Plate frames were used in most cases, but three of the German engines had bar frames. Cast steel was used generally for the wheel centers. The crank axles were of special grades of steel (mainly nickel steel); those of the German engines were bored at the center.

The cabs were generally spacious, and on the large engines the sides are bent so as to keep within the clearance limits. Many of them have seats for the men (which is a comparatively modern equipment for foreign engines), and on the German and Belgian engines sliding doors closed the open space between the cab and the tender. In some of the engines the cab had a "wind-splitting" wedge-shaped front, and in many of them the cab had a monitor roof with deck ventilators. The cabs of the German engines also had name plates over the various operating levers, valves, etc., and some of them had compressed gas for lighting. All the high speed engines were equipped with speed indicators of some kind. The greatest total height to top of smokestack was 14 ft. 3 ins., and in a majority of cases this height was 14 ft. or less. Of the 36 engines, 26 had the Westinghouse brake, 3 the Knorr brake, 3 a steam brake, 2 the Westinghouse-Henry brake, and 2 a vacuum brake.

Secondary Locomotives.

Of the 20 locomotives of this class, 11 were for industrial railways, 6 for secondary or local railways and three for colonial railways. Those with four and six driving wheels presented no special features, except the use of the Schmidt superheater in three cases. The two eight-coupled engines and the Mallet engine were notable on account of their high power for narrow-gage railways (3 ft. 3⅜ ins. and 3 ft. 6 ins.). The Mallet 60-ton engine for the Guinea Railways (Kanakra to the Niger), takes trains of 800 tons on grades of 0.7 and 0.8% at 9½ m. p. h. and trains of 225 tons on grades of 2% at 18 m. p. h. All were tank engines (including the Mallet engine), except two for export which had eight-wheel tenders). All had outside cylinders. The total weight ranged from 14 to 50 tons (or 60 tons for the Mallet engine). An engine of the 0-6-0 class for local lines in Belgium (laid partly in streets and along the sides of country roads) had a steel cabin or housing to enclose the machinery and boiler. A roof extended the entire length, including a platform or cab at each end. This arrangement is common for engines on lines of this class.

An industrial locomotive of English make (not included in the railway exhibit) was a tank engine of the 0-4-0 class fitted with a 4-ton crane. A turntable above the cab carried a horizontal counterweighted boom; this boom could hoist 2 tons at 20 ft. radius, 3 tons at 15 ft., and 4 tons at 12 ft. The machine was intended for use at docks, freight yards, manufacturing plants, etc.

BRICK PAVING FOR COUNTRY ROADS is to be adopted in Washington Co., Pa. The county authorities have arranged to issue half a million dollars in bonds for highway improvement, and have specified that brick instead of macadam is to be used for the surface.

THE CRUSADE AGAINST THE AUTOMOBILE smoke nuisance by the New York Department of Health resulted in 1,819 arrests between Sept. 29, 1910, and April 26, 1911, inclusive. In 1,655 of the cases fines aggregating $4,556 were imposed. Five of the persons arrested are yet to be tried; sentence was suspended in 84 cases and 75 were discharged.

The Experimental Imhoff Sewage-Clarification Tank at Philadelphia and the Original Tanks in the Emscher District of Germany.

With Introduction by RUDOLPH HERING,* M. Am. Soc. C. E.

Introduction.

Mr. Charles Saville, of Essen, Germany, has sent us the enclosed notes for you concerning the Philadelphia tests of the Imhoff tank, one of the first trials made in America on the new method of sewage sludge digestion. He makes a useful comparison between the results obtained at the "Home Station" in the Emscher District and those obtained with American sewage which, as a number of cities are now considering the introduction of this method, will be helpful to some of your readers. He reports that the gratifying results which he and I saw together last summer in Europe are being maintained, that the doubts and fears which have been expressed here and there regarding the evolution of hydrogen sulphide and other foul-smelling gases have not materialized, that the gases of decomposition and the sludge itself are without offensive odor, that if there was any hydrogen sulphide in the influent sewage there was less in the effluent, and that the tanks have a disposition to give more uniform results after six months' operation when they are in working order than at first during the starting or testing period. Sewage, therefore, continues to be purified closely in settled districts without offensive odors.

Mr. Saville calls attention to the important result that the percentages in the dry residue of volatile, nitrogenous and fatty matters are as low in the Philadelphia sludge as in that of the Emscher District, notwithstanding that the average percentage of total solids removed is much less.

It remains yet to be determined whether any of our highly sulphated waters after passing through the tank will produce sludge with foul smelling gases that cause our older sewage disposal plants to be offensive, provided the sewage is fairly fresh when it reaches the works. It further remains to establish the time difference, if there is any substantial difference, in the rate of subsidence between the stronger European and more dilute American sewages, both flowing the same distance with the same velocity.

Additional Notes From the Emscher District.†

By CHARLES SAVILLE.‡

The recent report of the Bureau of Surveys, Philadelphia, on the work at the Spring Garden sewage testing station, contains many well-arranged data about modern sewage treatment methods that will prove of value to those having charge of the design or operation of disposal works. It is of special interest to me because of the information given relative to results obtained with a small experimental sewage clarification tank of the so-called Emscher or Imhoff type. The work of the tank is discussed from two points of view: (1) clarification of the sewage; (2) amount and character of sludge to be disposed of.

CLARIFICATION OF THE SEWAGE.—The average per cent. removal of total suspended solids in the Philadelphia crude sewage is given as 52, the period of sedimentation being two hours. The tank was 5 ft. in diameter and 10 ft. deep. The length of the test, about three months. The relatively small efficiency indicated by the figure just given can, without doubt, be accounted for in part (as suggested in the report), by the small size of the tank which allowed of sedimentation during a radial downward and upward movement of the sewage through a vertical distance of only 4.5 ft. The tanks operating in the Emscher District remove 70% or more of the total suspended solids. They are from 25 to 30 ft. in diameter and have a depth of at least 25 ft. Average analyses of the sewage and settled effluent at three of the largest works are given in the accompanying table. The determinations (of suspended solids) are in parts per million and show the character of the sewages during the six hours of the day when they are strongest. The analyses are therefore not directly comparable with those of the Philadelphia sewage which have been taken from the report in question. The period of sedimentation at the German installations is only from ¾ to 1½ hours, and in spite of large variations in the quantity of suspended matter in the applied sewages the character of the effluents of the tanks is quite uniform.

A comparison of the clarification of entirely different sewages by means of "per cent. removal" of total suspended solids is at best somewhat unsatisfactory. Such a comparison would have more value if made with per cent. removal of "settling" suspended solids; namely, that portion of the total solids in suspension which will settle when allowed to stand quiescent in a measuring glass for two hours. It will be noted (in the table) that in spite of a low percentage removal, the total suspended solids in the effluent of the Philadelphia tank were small in amount and less than at any one of the three German plants. The analyses indicate that these German sewages contain considerably more suspended matter than the sewage experimented with at the Spring Garden testing station.

With properly designed tanks of the Imhoff type it should be impossible for any of the sludge (after settling into the decomposing chamber) to rise again through the slots into the sedimentation chamber and pass out with the effluent. This is prevented: (1) by making the upper portion of the sludge-decomposing chamber (above the slots) large enough for the sludge to move about freely under the influence of the rising gases, and (2) by removing sludge from the bottom of the tank with sufficient frequency to prevent the upper surface of the main sludge deposit rising above a point 2 or 3 ft. below the slots. In studying the results of the test at Philadelphia it should be remembered that the tank was in operation for only a comparatively short period. The conditions of decomposition in the sludge chamber of such a tank are likely to be more uniform after the first six months, and there is then less movement in the sludge deposit.

The Philadelphia report states that

> The Imhoff Tank studied illustrated the principle involved, inasmuch as the substantial separation of the sewage flow from the digesting sludge keeps the sewage fresh and eliminates offensive odors . . . there being no appreciable loss of dissolved oxygen nor reduction of nitrites or nitrates during the short time of passage through the tank.

Similar results are obtained with the full-sized tanks in Germany. At certain times the raw sewage entering these tanks contains small amounts of H_2S and has a slight septic odor as a result of the discharge into the sewers of septic sewage from house cesspools. Numerous tests have shown, however, that under such conditions the effluents of the tank contain less H_2S than the inflowing sewage.

For a satisfactory solution of the sewage disposal problem well designed and carefully built sewers, which will deliver the sewage in a fresh condition, are just as important as an efficient plant for treatment of the sewage.

AMOUNT AND CHARACTER OF THE SLUDGE.—Any comprehensive scheme of sewage treatment should provide not only for proper clarification of the sewage—and when necessary, for oxidation of the organic matter dissolved in the water, as well as disinfection of the final effluent—but also for a satisfactory disposal of the sludge. The importance of the sludge problem is strongly emphasized in the Philadelphia report. It is shown that the *volume* of sludge to be handled depends largely on its water content.

The sludge removed from the small Imhoff tank in Philadelphia contained as low as 75% and averaged 82.6% moisture which was less than in the sludge from any other type of tank experimented with. The water content is influenced not only by the length of time sludge remains in the tank; but likewise to a considerable extent by the depth and general arrangement of the sludge decomposing chamber. With the small shallow tank used at Philadelphia one would not expect such good results as in the case of full-sized plants. Sludge when removed from tanks in the Emscher district has an average water content of less than 80%.

The quantity of sludge removed from the small Imhoff tank is given as 0.9 cu. yds. per million gallons of crude sewage treated, which is less than one-quarter of the amount (4.07 cu. yds. per million gallons—86.1% moisture), taken from an ordinary sedimentation tank treating the same kind of sewage. The period of sedimentation in this tank is reported as 3½ to 6 hours instead of 2 hours in the Imhoff tank. A comparison of the figures would be more instructive if the period of sedimentation had been the same in both tanks. Results with sewages of entirely different character are not readily comparable; but it may be of interest to know that the amount of sludge removed from the tanks at Recklinghausen, Bochum and Essen, N.W., in Germany, is 1.65, 2.10 and 1.39 cu. yds., respectively, per million gallons of sewage treated.

The *condition* of the sludge withdrawn from the small tank of this type operated at Philadelphia is described as

> different from any other. . . . Fermentation in the sludge chamber had broken down even resistant bodies, and the resultant sludge was fine, granular and homogeneous . . . flowed freely and did not have an offensive odor.

The sludge removed from the full-sized tanks in the Emscher district has these same characteristics, likewise the decidedly "tarry" odor mentioned in the Philadelphia report disappears entirely in a few days. This tarry odor is absolutely unobjectionable and cannot be detected at a short distance. The report further states that the per cent. of the dry residue in the sludge found to be volatile was 38, as compared with 50 in fresh sludge removed from an ordinary sedimentation tank. The nitrogeneous matter and fats in the sludge removed from the Imhoff tank are also shown to have been less than in the sludge removed from any of the others. The volatile matter in dried residue of sludge from tanks operated by the Emschergenossenschaft is somewhat greater than

COMPARATIVE DATA FROM IMHOFF SEWAGE-CLARIFICATION TANKS IN THE EMSCHER DISTRICT, GERMANY,* AND THE PHILADELPHIA SEWAGE TESTING STATION.

TABLE OF DATA RELATING TO OPERATION OF IMHOFF TANKS.

Determination.	Recklinghausen.		Bochum.		Essen-N. W.		Philadelphia.	
	Sewage.	Effluent.	Sewage.	Effluent.	Sewage.	Effluent.	Sewage.	Effluent.
Total suspended solids	466.6	127.5	402.0	93.3	449.8	135.4	193.0	92.0
Organic suspended solids	259.3	73.5	186.9	56.4	261.6	85.6	137.0	73.0
Mineral suspended solids	207.3	54.0	215.1	36.9	188.2	49.8	56.0	19.0
Av. per cent. removal total suspended solids	72		77		70		52	
Period of sedimentation (hours)	¾-1¼		1-1½		½-1		2	
Sludge—Cu. yds. per million gallons	1.65		2.1		1.39		0.90	
Per cent. moisture as withdrawn from tank	82.9†		78.1		75.6		82.6	
Per cent. moisture after drying	65.2		63.3		52.3		64-68	
Per cent. of dry residue—volatile	45.3		38.1		54.9		38.0	
Per cent. of dry residue—nitrogenous	1.7		1.2		1.2		1.2	
Per cent. of residue—fat	6.9		6.1		4.9		6.5	

*Figures for the German plants are taken from "Technisches Gemeindeblatt," for March, 1911. They do not necessarily agree with average figures, quoted in the text, since the latter refer to all plants of the Emschergenossenschaft.

†The sludge room or space of Recklinghausen is not large enough to allow of complete decomposition of all the organic matter in the sludge before withdrawal. The sludge therefore has a higher per cent. of moisture and requires longer to dry; but is otherwise entirely satisfactory.

*Consulting Engineer, 170 Broadway, New York City.

†For a general description of the Emscher Sewerage District and Imhoff tanks there see Eng. News, Dec. 1, 1910.

‡Assistant Engineer, Sewerage Department, Emschergenossenschaft, Essen, Germany, formerly Assistant Engineer, Massachusetts State Board of Health, Boston, Mass.

38%. Figures are given in the accompanying table.

The sludge at Philadelphia contained (on removal from the tank) the small gas bubbles which are so characteristic of sludge at the German installations, and whose expansion plays such an important part in the rapid drying of the sludge. At the Spring Garden testing station a 6-in. layer of sludge dried during winter weather in 10 days, the per cent. of moisture being then reduced to 64. It has been found in the Emscher District that freezing weather interferes with rapid drying principally if it occurs during the first 24 hours after the sludge has been discharged from the tank and when the contained gas bubbles are expanding to make the sludge so porous and light that it can float on the water which drains out of it. A heavy rain storm on the day of withdrawal may also interfere with these actions. It is of course desirable to have the drying beds well drained. The storage capacity of the sludge decomposing chambers in the tanks should be large enough so that it is unnecessary to remove sludge during the coldest weather, and for quick drying, the beds ought not to be covered with sludge to a greater depth than 10 ins. The average drying period in the Emscher District, where there is little continued cold weather, though many rainy days, is about 7 days. In summer, sludge is sometimes removed from the beds after 2 days. The per cent. of moisture in the "dry" sludge varies from 55 to 65.

One other thing mentioned in the Philadelphia report might be referred to: namely, the formation of a scum on the surface of the sewage in the sedimentation chamber. This was without doubt due in large measure to the size of the tank and the small area between the inlet channel and the circumferential baffle. A genuine thick scum on the surface of the sewage does not form in the sedimentation chambers of the full-sized tanks here in Germany. Organic suspended solids which accumulate at times behind the baffle gradually become water-logged and sink. Matches, corks and grease or oil floating on the surface of the sewage are skimmed off at regular intervals and burned.

The success with which the small Imhoff tank was operated in Philadelphia should be a matter of considerable interest to engineers and others having to do with sewage disposal. The sewage treated was apparently typical in many respects of the sewages in large American cities, while the results obtained compare favorably with those of the German plants already referred to. They are: (1) a well clarified fresh effluent, and (2) absence of objectionable odor from the effluent, from the gases given off during decomposition of the sludge, or from the sludge itself after removal from the tank. In other words, it would appear to be possible to operate such tanks in thickly settled localities without creating a nuisance. They require but little space and the character and quantity of the sludge is such that the drying beds do not have to be large. With the completion of the full-sized tanks now being built to serve a section of the city of Philadelphia it will be possible to learn still more about the applicability of this type of tank to American conditions.

The Prevention of Fire.*

By W. H. MERRILL.†

Fifteen years is a brief space of time in the history of an organization; it is briefer in the history of a nation. Yet for our country, this period includes the San Francisco, Baltimore, Chelsea and Bangor conflagrations, the Windsor, Iroquois, Collingswood, Boyertown, Slocum, Lenox, Cherry, Newark, Chicago Stock Yards and Asch disasters; not a day without its long list of properties destroyed and not a month without record of the sacrifice of human life. It marks a burnt offering of more than two thousand million dollars worth of our created sources, and the lives of more than twenty thousand of our people.

Had these twenty thousand persons been killed fighting for their country rather than simply for their lives, their fame would be everlasting. Had these two billions of property value been wiped out by the invasion of a foreign foe, the call for defense would meet with a universal response. But west of the Mississippi people are a bit hazy as to whether a thousand souls perished with the Steamer "General Slocum" from fire or shipwreck, and east thereof not altogether certain as to how or whether each one should play a soldier's part in combating this common enemy—FIRE.

If people will listen, we must continue to speak of these things, and we must continue to show them how through the various agencies of the National Fire Protection Association each one may do his part for the common good. It is therefore well that we have our record of 15 years of earnest, constant, efficient work, that we may supply the ever increasing demand for solutions of the problems involved by this enormous waste.

We prescribe real buildings of fireproof construction, not shells with unprotected vertical and horizontal openings, and finished or equipped with combustibles; real fire windows, not merely things of glass and metal; real fire doors with fire-door (not ordinary hardware; real automatic sprinkler installations, not partial or ineffective equipments or perforated pipes; real fire hose, not the common shoddy substitute; real first aid appliances, not those which require fires educated to meet their limitations; real fire signaling systems; real structural methods and materials; real fire fighting apparatus; and so on through the whole field of fire protection.

In the field of fire prevention, this, our fifteenth year, marks the assimilation by us of the work of three National Institutions, which have been energetically and successfully engaged side by side with us throughout our existence. It is a matter of satisfaction to feel that all parties in interest have had that high degree of confidence in the National Fire Protection Association necessary to influence them to entrust to us the future of the National Electrical Code, a standard for safeguarding electrical work which is adopted as the law of more municipalities and the rule of a greater number of other organizations with authority than any other set of specifications in existence. Of equal importance is the fact that we are henceforth to carry forward the various National Standard specifications covering the hazards of explosives and combustibles, to keep them in step with progress in the several arts, and to compile new standards for new subjects when the need is apparent. We have designed, advocated and caused to be installed in many cities and towns the National Standard uniform thread for hose couplings and hydrant fittings, thus relieving in a greater measure each year the deplorable and unwise conditions which have prevented the fire apparatus of one town being of any considerable aid to its neighbor in case of emergency.

The National Fire Protection Association extends its welcome to each passerby who may express an interest in fire protection or fire prevention. He may join the effort for the general good which has been crystalized, and is being carried forward through the constantly broadening influence and work of this Association. Each one may obtain for himself through this agency information and advice on matters of fire protection engineering from experts trained in this profession, and at the same time add his helping hand and the moral influence of his membership to the effort of the thousands of loyal soldiers already enlisted, and doing brave battle against the evil spirits of the flame.

Efficiency is a popular word to-day. Efficiency in fire protection and prevention is defined by a joint national effort for the common good. Ninety-two of the principal national Engineering Societies, national Manufacturers' and Merchants' Associations and Boards of Underwriters are united in the active membership of our organization for the sole purpose of economically and effectually producing results of practical benefit in safeguarding the lives and property of the American people against loss by fire; more than a thousand local Boards, Bureaus, Departments and individuals are included in our associate membership, because they recognize the power of collective action; upwards of 700 persons, firms and corporations are enrolled as subscribing members, both because of the benefits they derive and the benefit they give.

This national disease cannot be entirely cured, because we cannot rebuild our cities, or immediately alter the characteristics of the American people. We shall have other conflagrations and further fire horrors as penalties for the negligence of years. The priceless papers and records of other states, like those of Missouri and New York, may serve the ignoble purpose of fuel for a wanton flame. People may be burned in dozen lots and be forgotten by many, as doubtless are those who perished in the lesser disasters at Yore's Opera House in Benton Harbor, Robinson's in Cincinnati, the Klondike at Milwaukee and the Lincoln and Fish fires at Chicago. It is wholly possible that persons in one of our great office buildings may yet come to the same fate as the crowded workers of the Triangle Waist Company.

But we can save the next generation from much of the shame attached to ours. We can eradicate severe conflagration conditions in many of the cities; we can safeguard premises where large numbers of people congregate; we can minimize hazards of all kinds; we can attack the common causes of fire in our own [illegible] in our neighbors' homes; we can specify effective [illegible] crushing apparatus; we can promote fire inquests; we [illegible] supply material for popular education on the signifi[illegible] of the fire waste. In short, we can go about the [illegible] of fire defense.

*Extracts from the Presidential Address at the annual meeting of the National Fire Protection Association, New York City, May 23.

†87 Milk St., Boston.

A New Cane Sugar Process.

A new process of sugar-making is be[illegible] tried by one of the large sugar companies [illegible] Cuba. In the ordinary process the juice is [illegible] tracted from the cane by pressing it between [illegible] sets of rollers. In the new process the cane [illegible] broken up, dried and finally treated by a di[illegible]sion or a solution process, similar to that used [illegible] treating sugar beets, which recovers a large [illegible] proportion of the juices than can be reco[illegible]red by squeezing between rolls.

The cane is fed to a disintegrating [illegible] machine having drums, 4 ft. diameter, which [illegible] fitted with teeth and have a peripheral speed [illegible] of about 6,500 ft. per min. The cane is thus [illegible]ken up very small, about half the product [illegible]sembling coarse sawdust while the remainder [illegible]sists of short thin fibers. The two kinds of ma[illegible]rial may be separated in a revolving screen or may be handled together. This product is fed by force-feed rollers into drying kilns where it travels back and forth on conveyor belts running in opposite directions. These belts are staggered about 18 ins. and the material from each belt falls to a lower one running in the reverse direction. Air heated to about 190° by exhaust-steam radiators is admitted to the kilns and is further heated to 240 or 250° by means of live-steam coils. The feed of material into the kiln and the speed of the belts in the kiln are under the control of the operator, who also controls the admission of exhaust steam to the radiators and live steam to the superheating coils.

The dried material is discharged from the lowest belt onto a transverse elevating conveyor which delivers it to a compress or baler; the bales are about 14 × 18 × 36 ins., with a density of about 50 lbs. per cu. ft. The material can then be stored or sent direct to the refinery, where the sugar is extracted by the diffusion process. The pulp remaining contains but a very small proportion of sugar (only a fraction of 1%) and it is suitable for paper-making with much less cooking than is required with ordinary material. The process is the invention of Mr. Geo. W. McMullen, of Chicago, and the first plant is now in experimental use at a mill of the Nipe Bay Co. The machinery was built by Roberts Brothers, of Chicago.

Under the ordinary roller process the cane is fed in layers, 6 or 8 ins. thick, to a set of three large rolls (two lower and one above); these crush and compress the cane and expel the juice. The crushed cane then goes to a second set of rolls and more juice is expelled, but after all the rolling the crushed waste material or "bagasse" contains a considerable proportion of sugar (from 15 to 30%). Much of the bagasse is fed to the furnaces, but is so wet that a considerable amount of wood is required to make it effective as fuel.

CEMENTATION OF WET GROUND.—A most interesting method used in connection with shaft sinking or tunneling through water-bearing ground has been developed in the Pas-de-Calais coal district of France, which is termed "cementation." The coal measures of the district are overlain with bedded marls and chalks, more or less fissured, and the fissures in some places are so filled with water that ordinary methods of shaft sinking would fail. Heretofore, the freezing system has been successfuly used, but the new cementation method can be employed at less cost. In one instance, the cost of cementation through 343 ft. of water-bearing ground was $13,200. Briefly, the process used by this company is to drill a set of holes in the water-bearing ground, six in number, arranged in a circle, surrounding the site of the proposed shaft, and then to pump a cement grouting through the holes until the fissures and interstices are filled. Shaft sinking is then proceeded with as it would be through ordinary rock strata. The system seems applicable to many situations where water is encountered in either shaft sinking or tunnel driving in broken rock.—George S. Rice, U. S. Bureau of Mines, before the National Association of Cement Users.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.
220 BROADWAY, NEW YORK

BRANCH OFFICES
CHICAGO: 1138 Monadnock Block
WASHINGTON, D. C.: Home Life Building
SAN FRANCISCO: Monadnock Building
REPRESENTED BY MOSSE, BERLIN AND HAMBURG, GERMANY
M. MARUYA & CO., Ltd., TOKYO, JAPAN

GEORGE J. FROST, President
CHARLES WHITING BAKER, Vice-President
FRANCIS C. FROST, Secretary and Treasurer

ALFRED E. KORNFELD, Manager

CHARLES WHITING BAKER, M. N. BAKER, E. E. R. TRATMAN, F. E. SCHMITT, } Editors

SUBSCRIPTIONS

United States and Possessions, Mexico and Cuba, One Year, $5.00.
Canada, One Year; $7.00; Thin Paper Edition, $6.00.
Foreign Countries, Regular (Thick Paper) Edition, One Year, $9.00 (£1-18-0), 45 Francs or 37 Marks.
Foreign Countries, Thin Paper Edition (Construction News Supplement Omitted), $7.00. 29 Shillings, 35 Francs or 29 Marks. Remit directly to our office.
Remit by Post-Office or Express Money Order, Draft on New York or London, or by Registered Letter.
Notice of change of address should reach us one week in advance of removal. The old as well as the new address should be sent.
Subscriptions cannot be dated to commence with past issues.
All subscriptions commence with current issue and back numbers can be supplied only by special order.
Receipts for Subscriptions will not be sent unless requested, the changing of the expiration number being considered sufficient. The number on the address label indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year. Thus 521 means the 52d week or December 28, 1911.

ADVERTISING

"Contract": Rates furnished on application.
"For Sale": $1.50 per inch.
"Proposal": $2.40 per inch.
"Want": See "Want" Pages.
Copy for regular, or "Contract," Advertisements should be received at least two days before publication; "For Sale" and "Situations Wanted" Advertisements by Monday, and "Proposal" and "Situations Open" Advertisements by 9 A. M. Wednesday.

Entered at the New York Post-Office as Second-Class Matter.

There is talk of creating still another sectional commission to deal with sewage disposal problems in New York State. As many of our readers know, a special commission has been investigating and reporting on the pollution of the waters surrounding New York City for a half dozen years or more, and recently secured a further lease of life. Now comes a scheme from the extreme opposite end of the State to establish a "Niagara Frontier Sewer and Water Commission" to report on ways and means of dealing with sewage disposal and water supply questions pertaining to the Niagara River and communities upon it, including Buffalo, the Tonawandas, Niagara Falls, Lockport, Lewiston and Youngstown. It is stated that the proposition is to have Governor Dix appoint an unpaid commission to prepare a plan of action for submission to the Legislature. The scheme seems to be in part the outgrowth of the Niagara Frontier Pure Water Conference, of which Mr. William M. Mills, of North Tonawanda, is President, but further than this we have no definite information as to its origin and scope.

Against the investigation of water supply and sewage disposal problems per se, whether in southeastern or northwestern New York, we have nothing to say, provided it be done by properly constituted and thoroughly representative agencies, and in such a way that it is not likely to be duplicated by those who are really responsible for existing conditions and remedial works. But it does seem to be a grave mistake for New York or any other State to go on creating special commissions having little or no responsibility to any branch of the government, the conclusions of which no branch of the government is in any way bound to follow. If a comprehensive investigation of the water supply and sewage disposal problems of Buffalo and vicinity is really needed and is beyond the capabilities of the several communities acting independently, why should not all of them unite in employing a competent engineer for the purpose? If some of the communities are unwilling to cooperate in engineering studies or in remedial works, so that mandatory State legislation is needed, and if the Legislature needs advice in the premises, then why should not the Legislature call upon existing State departments for that advice? Or if there be objections to this plan, why should not the Legislature authorize the Governor to employ a high-grade consulting engineer, and if need be an attorney of equal standing, to recommend the proper lines of engineering and legal action? Either plan would be better than to create a special State commission to deal with a subject which is primarily local and which, in so far as it is a State problem, is primarily a matter of ascertaining what the State ought to compel or authorize the several localities to do, rather than to tell them how to do it.

The United States was the only nation of first importance, if we remember rightly, which was not officially represented at the Brussels International Road Congress last summer, and it appears that substantially the same state of affairs is occurring in connection with the International Hygiene Exhibition, which is being held at Dresden from May to October of this year.

The U. S. Department of State requested Congress to appropriate $50,000 to enable our government to make a creditable representation at Dresden, but the last session of Congress did not act favorably upon the request. Although rather late in the day, there is still an opportunity for Congress to make an appropriation which would allow this country to join other nations at the exhibition.

Congress may be tired of making appropriations for exhibitions of one kind or another. We do not pretend to say whether or not it is justified in withholding an appropriation in this particular case, but on general principles it might be expected to join with other leading nations of the world in all really meritorious exhibitions, unless it adopts a definite policy to the contrary.

Failure to show itself officially at the Dresden Hygiene Exhibition is a minor matter compared with the absence of the United States from tabulations of vital statistics of leading nations of the world published yearly in the reports of the Registrar-General of England and elsewhere. This country is absent from those lists, because the United States as a whole has not sufficiently reliable statistics of deaths to warrant their publication for comparative purposes. Our statistics of births and marriages are even more hopelessly incomplete and unreliable. The backward state of affairs is chargeable to the government of the several deficient States rather than to the federal government, and ought to be remedied at an early date.

The Law Regarding Control of Waters Crossing State Boundaries.

The proposal made in these columns two weeks ago that New York City should resort to the Ten Mile River, north of the Croton watershed, for an additional supply of water to protect it against the danger of water famine, has been criticised chiefly on legal grounds. The Ten Mile River flows across the state boundary into Connecticut immediately below the site proposed for a pumping station to draw water from the river and pipe it over into the headwaters of the Croton. It is claimed, therefore, that any riparian owner lower down the stream in Connecticut could bring suit in a Federal Court and stop by injunction the diversion of the river.

In our original proposal we attempted no more than to point out the obvious engineering remedy for New York's present situation, and to raise the question whether the legal profession could not find a way to overcome any difficulties with respect to riparian rights and interstate complications and enable engineers to proceed at once with works to save New York from the danger of water famine.

In reply to our suggestion, however, it was alleged that the legal difficulties in the way were so great that the Ten Mile River could not even be considered as an additional source of supply. We gave some reasons in our last issue for believing that the legal obstacles in the way of appropriating the water of an interstate stream to meet an emergency are by no means so formidable as has been claimed. In the present issue we continue the discussion by printing on another page an opinion on the law of interstate waters prepared by Carman F. Randolph, Esq., for the Merchants' Association of New York City.

This opinion was prepared by Mr. Randolph in response to a request from Mr. William F. King, President of the Merchants' Association, as to whether New York City could lawfully obtain an additional supply of water from interstate rivers. While this opinion was prepared by Mr. Randolph in 1904, it is well worth publication at the present time, since it cites many legal authorities bearing upon this important and yet little-understood subject. It has been cited by M. Nys in a treatise on International Law and was recently quoted by the New Jersey Court in McCarter v. Hudson County Water Co. 70 N. J. Equity 717.

The question of interstate water rights is one of such great and growing importance, and bears so directly upon engineering work, that its discussion in these columns seems well worth while. The general public has little comprehension of the enormous loss and waste that has already taken place and of the much greater loss which will take place in the future unless the law concerning interstate waters can be put on a basis in harmony with present-day necessities.

There can be no more forcible illustration of the enormous loss resulting from our blind adherence to the ancient law of riparian rights and our failure to remedy the conflicting control over interstate streams than the work now in progress to provide an additional water-supply for New York City.

How many tax-payers of New York City realize that the city is paying fifty million to a hundred million dollars MORE to secure a new water-supply from the Catskills than it would have had to pay to secure a supply of equal quantity, equal pressure and equal purity from the upper Housatonic River, in the State of Connecticut? Not only might New York City have saved this enormous sum but the supply from the Housatonic could have been obtained in little more than half the time that is necessary to secure the supply from the Catskills. Had New York been able to take the Housatonic supply when it was recommended, eleven years ago, it might already be in possession of an ample supply for all its needs and be freed from the danger of water famine which now hangs over it and will probably continue to threaten it to a greater or less extent for two or three years to come.

As many of our readers will remember, the upper Housatonic River in Connecticut, with its branch, the Ten Mile River in New York State, were recommended by Mr. John R. Freeman eleven years ago as the best and most economical source for an additional water-supply for New York City. The total estimate of costs for this supply made by Mr. Freeman, including damages to all riparian owners affected, storage and distributing reservoirs, aqueducts, and all legal, engineering and other expenses, was about $52,500,000. The estimates for the new Catskill supply indicate that its cost will exceed $160,000,000 in round numbers.

Engineers were agreed that the Housatonic River was by far the most economical and most readily available supply for New York City, but the proposal to secure it was condemned by the lawyers employed by the Merchants' Association on the ground that there was no possible legal procedure by which the rights of riparian owners on the Housatonic River in Connecticut could be subjected to the law of eminent domain in order to enable New York to divert any substantial part of the waters of that stream. In view of this opinion, no further attention has since been paid to either the Housatonic or Ten Mile River. The Burr-Hering-Freeman Commission, which investigated the whole matter of additional water-supply in 1903, confined its work to the streams flowing into the Hudson River and located in New York territory.

While New York City suffered an actual loss of

from $50,000,000 to $100,000,000 or more through its inability, because of the impotency of the law, to go across a state boundary for an additional supply of water, it should be noticed that no corresponding benefit was reaped by the State of Connecticut or its inhabitants. The Housatonic River flows onward to the sea to-day as it it has for centuries past, unused save for such trifling uses as may be made by the farmers living along its banks and the development of water power at three or four sites where a fall occurs in the stream. But any and all of these uses are insignificant in public benefit and value compared with the utilization of the river to furnish a potable water-supply for a great city. That city could have well afforded to pay ample damages to every resident of Connecticut having a riparian right in any way affected by the city's diversion of the water, and would gladly have done so had any legal method been open by which the compensation could have been made.

Since New York was compelled to make the huge additional outlay above mentioned to secure a supply of water from a more remote source, and since the riparian owners in Connecticut reap no compensating benefit from continued use of the stream, the defect in the law actually produces a public calamity.

The public loss is as great as if a conflagration or a flood or a tempest had destroyed property worth fifty million to a hundred million dollars.

As some of our readers know, English law is far in advance of American law with respect to the diversion of water from a stream for public water-supplies or other purposes. An English city which goes to a river in some remote country district to obtain a potable water-supply for its use is obliged to build storage reservoirs upon the stream, which conserve the flood waters and regulate the flow. The city is not allowed to take for its use the whole flow of the stream, but must keep a reasonable volume, known as "compensation water," steadily flowing down the channel at all times. The owners of lands or mill sites lower down the stream clear to its mouth are assured of this permanent, uniform flow. They are benefited rather than injured by the city's building its reservoirs and taking the flood water for its use, because they are relieved from the danger and damage due to floods and are assured of a larger flow in the stream during summer drought than would occur with the stream in its natural condition.

This common sense procedure has the sanction of law in Great Britain; but in the United States, through a most unfortunate ruling of our Supreme Court, it has been held that the constitutional requirement that private property may not be taken for public use without due compensation, means compensation in money. Under these conditions, therefore, an American city going to a river for its water-supply is obliged in the first place to pay heavy money damages to riparian owners and can then entirely take away the natural flow of a stream and thus do permanent injury to a whole section of country which can hardly be compensated for. The sensible method of storing flood water and thus protecting the riparian owners from damage at moderate cost is not open to the American city at all.

The question of interstate rights in flowing water is important in many other places than New York. Already, a considerable number of these cases have been before the courts and have been carried to the Supreme Court of the United States. To-day, there are cases not a few where engineering enterprise is greatly impeded and hampered because of conflicting jurisdiction over water due to international or interstate boundaries,

A case happens to be before us at this moment in a prospectus recently issued by the Manufacturers' Association of Beaver Co., Pa., setting forth a plan for regulating the flow of the Shenango River. This river is subject to enormous variations in volume. Its flood flow is said to be 650 times its flow at the lowest stage of water. Regulation is desired not so much to prevent damages by high floods as to maintain the low water flow of the stream. Along the valley of the Shenango are a great number of blast furnaces. In times of extreme low water, these blast furnaces use five times as much water daily as flows down the river. Of course, the hot water from the furnaces is turned back into the stream, but it becomes so overheated that it has been known to reach a temperature in the open river of over 140°.

To conserve the flood waters for maintaining the low water flow in the river it is proposed to form a lake by flooding the great Pymatuning swamp on the head waters of the stream. This lake will so regulate the flow of the river that instead of the ratio between greatest and least flow being 650 to 1 it will be only 30 to 1. The map accompanying the prospectus, however, shows that this proposed lake will extend across the state line into Ashtabula Co., Ohio. If the hard-and-fast rule of law is sustained, under which New York was prevented from making use of the Housatonic River, then any owner of land in Ohio to be flooded by this proposed reservoir can appeal to the federal courts and absolutely prevent this great and beneficent work of conservation from being carried out.

We may suggest still another illustration: The Susquehanna River has its head waters in New York and flows across the boundary into Pennsylvania. Millions of dollars have been expended within recent years in Pennsylvania in the construction of power plants by which the energy of the river is utilized. The value of these power plants, however, is enormously reduced because of the great fluctuations in the river's flow, and during months of extreme low water it will be possible to operate these power plants to only a small part of their capacity. What is needed for the economic utilization of this great investment is the construction of storage reservoirs on the head waters of the stream to conserve the flow; but the power plant is located in Pennsylvania; the reservoir sites are in New York.

Numerous other cases might be cited where an amendment of the organic law, so that waters in one state may be conserved and utilized for the benefit of people in another state, is a most urgent necessity of the times. We are actually doing better in conserving and regulating the use of international waters than we are the waters which cross the boundaries between separate states of the nation. To control the waters in which Canada and the United States have a common interest, an International Commission was organized a number of years ago and has been able to pass upon questions of disputed right and to prevent the residents on one side of the boundary line from taking undue advantage of those on the other. In dealing with Mexico, too, the United States is now proceeding to store the flood water of the Rio Grande, in order to furnish a supply for irrigation to residents of Mexico who have been deprived of water for their irrigating ditches through the diversion of the river for irrigation purposes by those living higher up on its course in the United States.

As our readers well know, the conservation of our rivers—the prevention of floods and of pollution and the utilization of their waters to produce the greatest public benefit—is becoming more and more a burning question with every passing year. It is becoming more and more necessary that the law should recognize the principle that the higher use of water should take precedence over the lower; that the use of water for power, for example, should take precedence over its use for navigation; that the use for irrigation should take precedence over its use for power and its use for municipal supply should take precedence over all other uses.

The law must be so altered as to recognize that under the changed conditions of modern industrial life the railway has made the use of water for navigation vastly less important than a half century ago. That the development of the steam engine and the gas engine has made the use of water for power also far less valuable than a half century ago. For irrigation, on the other hand, the value of water is all the time increasing; and for the supply of water to cities, towns and villages—a use of water hardly known when the common law governing riparian water rights was developed—it is now well recognized by engineers that water attains its greatest usefulness and its highest value.

These principles must be embodied in the statute law, and in the organic law if necessary, or more lasting and serious injury to the public welfare will be done than has already occurred. Further than this, the principle that a higher use of water takes precedence over a lower must be made to extend across state boundaries. It is unthinkable that cities and towns shall be compelled to suffer for lack of water supply or to be put to enormous and needless expense in obtaining it simply that a river may continue to run through green meadows and fertile pastures to be applied to no higher use than watering cattle.

It is unthinkable that private property rights should continue to stand in the way of public welfare. The lawyers have so magnified the rights of private property, that instead of awarding the owner "just compensation" when his property is taken for public purposes, the public has to submit to legalized blackmail.

A great assemblage of lawyers in New York City last month, among them the President of the United States, convened to consider the reform of gross abuses in our criminal laws. We have gone so far in protecting the rights of the accused criminal that we have overlooked the rights of the public.

There is, we believe, equal need for the reform of our civil laws, where the law's delays likewise result in miscarriage of justice and where the right of private property, guaranteed by the constitution, has been so distorted that the rights of the public have been well-nigh forgotten.

Why Absolute Bacterial Standards for Potable Water Are Impracticable.

Absolute standards for the quality of public water-supplies have long been sought and many and various chemical, bacterial and physical standards have been set up for general adoption. Few of these have found wide acceptance and fewer still have stood the test of time and experience. It is now generally recognized that chemical standards for ordinary potable water have only a comparative value, and that chiefly for purposes of interpretation. Physical standards such as turbidity and color, are more positive than are chemical standards, but even these cannot be universally applied. Bacterial standards, which at first thought might seem subject to sharp definition and rigid application, are based on more or less presumptive results, which may be subject to more than one interpretation.

It should be remembered that we are discussing absolute bacterial standards, and are not throwing the lightest shadow of doubt on the value of the large amount of bacterial work being done every day in hundreds of water laboratories, distributed throughout the world. Our remarks have been prompted by a lengthy paper by Mr. H. C. H. Shenton, read on May 1, 1911 before the Society of Engineers (England) and printed in the London "Surveyor" of May 12. The paper consisted chiefly of a compilation of "conflicting statements" on bacterial standards, accompanied by a running comment and followed by "Conclusions." For the convenience of our readers we insert these "Conclusions" here:

The author's object in producing the number of typical conflicting statements given above is to attempt to bring home to the chemist and bacteriologist the impossibility under present conditions of agreeing upon any standard conformation with which shall prove that water is incapable of producing disease in a greater or less degree. What they can do, and what they ought to do, is to fix a standard which shall prove that the water is free from given definite organisms believed to be harmful. Thus, if absence of coli were insisted upon, one might be reasonably sure that typhoid germs were absent, but according to the statement of the scientists quoted above, absence of coli does not necessarily prove the absence of certain other organisms, more or less indefinite at pres-

ent, which they believe to be harmful in a minor degree.

Until we can be assured more definitely as to the exact nature of these other dangerous organisms, and to the manner in which they may be got rid of, it is obviously impossible to take much account of them. The true scientist is, above all things, conscious of the smallness of his knowledge. There may be an infinite number of harmful things present in water, of which we know nothing at present. Science may in time discover them or prove their absence, but it is impossible to take any serious account of them until they have been discovered.

With regard to coli, typhoid, and other well-defined water-borne disease germs, there is no such difficulty. If the scientist believes that they should be excluded, he should say so in no uncertain manner. If the scientist will fix his standard we as engineers are prepared to make any water conform to that standard. It matters not to the engineer whether water comes from a deep well, from a shallow well, from a river or lake, or from the surface of moorland. He is quite prepared to purify that water, however much it may have been polluted, so as to bring it up to the highest standard required by the scientist, and the scientist has no excuse for shifting his ground and modifying his standards so far as the engineer is concerned. The modern methods of purification are numerous, and there are plenty of examples in this country and elsewhere where water originally polluted is being brought up to a very high standard of purity. Doubtful and impure supplies ought not to be tolerated, seeing that the machinery exists for purifying them.

Although it is possible to purify water to any required degree, this does not afford the slightest excuse for acquiescing in the pollution of water-supplies. Here, again, it rests with the medical authorities, and with the chemist and bacteriologist, to insist strictly and uniformly upon the prevention of pollution. If they will do so, we, as engineers, are quite prepared to make all sewers, house connections, and house drains as watertight as we make our water mains. We are prepared to do away with every soakage pit or cesspit in the country; we are prepared to purify all sewage discharged at outfall works up to any degree of chemical or bacterial purity required. Yet the river Thames, from which the supply of London is drawn, receives the sewage of 800,000 persons, together with other impurities, which reach the river without any attempt at bacteriological purification.

At the present time an enormous amount of work is done in discovering the causes of pollution and in the work of purification both of water and of sewage, but no one has had the courage to tackle the matter in a whole-hearted manner. We all acquiesce in the pollution of our sources of supply and we all acquiesce in cutting down the cost of purification and protection works to a minimum. Some day it will be recognized that this is false economy, in the same way that it has been recognized that it is cheaper in the end to construct our roads, railways, bridges, machines, engines or buildings of the best material and in the best manner possible.

Mr. Shenton has done well in calling sharp attention to the many "conflicting statements" regarding bacterial standards for the purity of water. He also deserves commendation for urging greater unanimity and definiteness of opinion as to what is really essential to safeguard the public from polluted water-supplies. But he seems to over weight the value and to hold out too much hope for the realization of an absolute bacterial standard, while at the same time excluding the engineer from his proper part in standard making and in the modification or adaptation of standards to meet varying local conditions.

To us it seems that the variety of opinion which he cites reflects in part the unsettled state of water standards and in part the temperamental extremes of those who attempt to formulate standards. The "scientists" to whom Mr. Shenton appeals will never agree on an absolute standard so long as new data are being accumulated nor so long as human nature continues to make one man an idealist and another a rationalist, with a hundred intermediate between the two extremes.

Mr. Shenton goes farther than would American engineers in subordinating the engineer to the chemist and bacteriologist and "scientist"—whatever he may mean by the latter. Here men of the three professions either work in cooperation or else the chemist and bacteriologist are subject to the direction of the water engineer, or at least supply him with data from which he formulates a standard to suit the local conditions of each problem. In fact, it is the peculiar and responsible task of the engineer to utilize data from all available sources in the formulation of conclusions and the conception and execution of plans which will meet the varying physical and financial conditions of each locality which he is called upon to serve.

So far as professional ability is concerned, the engineer may be "quite prepared" to do any or all the very costly things mentioned by Mr. Shenton, but he would be untrue to his profession if he did this without being reasonably sure that the excess cost would yield proportionate benefits to the public health; or, to put it in another way, without satisfying himself and his city government that the excess cost could not be laid out more advantageously on some other object. We may be wrong, but we judge that it is almost as true in England as in the United States that there are ten demands upon the municipal treasury for every one that can be met in a given year. Under such conditions, counsels of perfection in any one department must generally give place to weighing and balancing of relative needs, and absolute standards must be modified accordingly.

Finally, we would be as glad as Mr. Shenton to see more rapid progress towards the establishment of absolute standards of water purity, but it will be many years before what may be called the *irresponsible* "scientist" or "medical authority," can set up bacterial limits of universal application for the *responsible* engineer and municipal authority charged with stretching sharply limited municipal revenues to meet demands upon them which are as limitless in number and variety as in amount. The aim of engineers and analysts alike should therefore be not for an absolute bacterial standard of water purity, but for a rational standard, readily adaptable to varying local conditions, including (1) the water-supply itself; (2) the municipal treasury; and (3) the other needs of the city, particularly those which affect public health.

LETTERS TO THE EDITOR.

One of the Problems of the Pyramids.

Sir: The following discusses an old problem, presented by certain coffers found in the pyramids of Egypt.

Proposition. — To design and cut out a rectangular block of stone of such dimensions and proportions that when its interior is excavated to form in effect a box without a lid, the thickness of the sides and ends being the same, the volume of the space inside shall be equal to one-half the volume of the original block.

Let Fig. 1 represent a general plan of the top of such a box, not drawn to scale. Let L, W, and h represent the length, width and height of the block of stone, and L', W' and h' the corresponding dimensions of the excavated part; then from the proposition as to volumes there results

$$L\,W\,h = 2\,L'\,W'\,h' \quad \ldots\ldots(1)$$

which may be put in the form

$$\frac{h'}{h} = \frac{L\,W}{2\,L'\,W'} \quad \ldots\ldots(2)$$

from which it appears that when $\frac{h'}{h} = \frac{1}{2}$, $L'\,W'$ becomes equal to $L\,W$ and the box has no sides, and when it becomes equal to 1, h and h' are equal and the box has no bottom. A solution of the proposition is therefore possible only when the ratio between the rectangles in Fig. 1 is greater than ½ and less than 1.

Let $\frac{1}{2}x$ represent the thickness of the sides and ends of the box, then from the statement of the proposition Eq. (1) becomes

$$L\,W\,h = 2\,h'\,(L-x)\,(W-x) \quad \ldots\ldots(3)$$

and Eq. (2) becomes

$$\frac{h'}{h} = \frac{L\,W}{2(L-x)\,(W-x)} \quad \ldots\ldots(4)$$

To make its solution possible, this equation must be reduced to one of simpler form by imposing some condition that will not conflict with the terms of the original

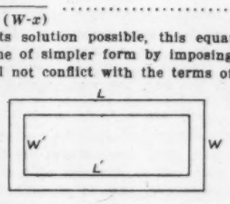


Fig. 1.

proposition. Such a condition is suggested by the form of the denominator of the second member; make $W = \frac{L-x}{2}$, or one-half the length of the inside rectangle. Then Eq. (4) becomes

$$\frac{h'}{h} = \frac{L}{2\,L-6x} \quad \ldots\ldots(5)$$

which is the general formula for determining the length of a stone box embodying the double volume feature and having sides and ends of equal thickness, ½ x. The length L being determined, the other horizontal dimensions follow directly from it. Let b represent the thickness of the bottom, then a solution of Eq. (5) is possible for any value of b less than $\frac{h}{2}$. For example, take $b = \frac{h}{3}$, then $\frac{h'}{h}$ becomes $\frac{2}{3}$ and Eq. (5) becomes $\frac{2}{3} = \frac{L}{2\,L-6x}$, and $L = 12x$. In other words, if the box is required to have a bottom equal in thickness to ⅓ its height, no matter what that height may be or in what unit of measure expressed, then the length must be 24 times the thickness of the sides and ends represented by ½ x, in order that the box shall possess the double volume feature.

If the thickness of the sides and ends is ½ ft., then from Eq. (5) it appears that the box will always be more than 6 ft. long.

Examples: 1. $b = \frac{h}{3}$ then $\frac{h'}{h} = \frac{2}{3}$ and $L = 12x$.

2. $b = \frac{h}{4}$ $\quad \frac{h'}{h} = \frac{3}{4}$ $\quad L = 9x$.

3. $b = \frac{h}{5}$ $\quad \frac{h'}{h} = \frac{4}{5}$ $\quad L = 8x$.

4. $b = \frac{h}{6}$ $\quad \frac{h'}{h} = \frac{5}{6}$ $\quad L = 7.5x$.

5. $b = \frac{h}{7}$ $\quad \frac{h'}{h} = \frac{6}{7}$ $\quad L = 7.2x$.

6. $b = \frac{h}{8}$ $\quad \frac{h'}{h} = \frac{7}{8}$ $\quad L = 7.0x$.

7. $b = \frac{h}{12}$ $\quad \frac{h'}{h} = \frac{11}{12}$ $\quad L = 6.6x$.

and so on until b becomes equal to h divided by infinity, when L becomes equal to 6 ft., but the box then has no bottom. If $x = 1$ ft., then in Examples 2 and 6 the horizontal dimensions are all whole numbers.

In Example 2, assume $\frac{1}{2}x = \frac{1}{2}$ ft.; then $L = 9$ ft., $L' = 8$ ft., $W = 4$ ft., $W' = 3$ ft., $L\,W = 36$ sq. ft. and $L'\,W' = 24$ sq. ft. Since $\frac{h'}{h} = \frac{3}{4}$, make h equal to 6 ft.; then h' becomes 4.5 ft. Substituting these values in Eq. (1), the first member or the volume of the exterior becomes equal to 216 cu. ft. or the cube of 6 ft., and the interior of the box is equal to one-half that or 108 cu. ft. If the height and depth are doubled, then the volume of the exterior becomes equal to 432 cu. ft. or twice the cube of 6 ft., while the volume of the interior becomes equal to 216 cu. ft. or the cube of 6 ft.

If in Example 2 the thickness of the sides and ends be made ¼ ft., then $L = 4.5$ ft., $L' = 4$ ft., $W = 2$ ft. and $W' = 1.5$ ft., $L\,W = 9$ sq. ft., $L'\,W' = 6$ sq. ft. Make $h = 3$ ft.; then $h' = 2.25$ ft., and Eq. (1) becomes $27 = 2$ (13.5). The volume of the exterior is a cube of 3 ft., that of the interior one-half that. Doubling h and h', the volume of the exterior, of course, becomes a double cube or $2(3)^3$, while the volume of the interior is the cube of 3.

Example 4 applies to the coffer in the Kings' Chamber in the Great Pyramid; the horizontal dimensions are in terms of the pyramid foot, as follows: $x = 1$ ft., $L = 7.5$ ft., $L' = 6.5$ ft., $W = 3.25$ ft., and $W' = 2.25$ ft.

Taking these dimensions, there results $L\,W = 24.375$ sq. ft., $L'\,W' = 14.625$ sq. ft., and Eq. (1) becomes

$$24.375 \times 2\sqrt{3} = 48.75\sqrt{3} = 2(14.625 \times \tfrac{5}{3}\sqrt{3}) = 2(24.375\sqrt{3}).$$

The cube of a cubit $(\sqrt{3})^3 = 3\sqrt{3}$, and $48.75\sqrt{3}$, divided by $3\sqrt{3}$, gives 16.25 or 16¼ cubic cubits for the volume of the exterior of the coffer, and 8.125 or 8⅛ cubic cubits for the volume of the interior. If $h = 3$ ft., then the thickness of the bottom, sides and ends is the same, ½ ft.

It would appear that the coffer in the Kings' Chamber was never intended as a measure of capacity. As to the values of h and h', the former is given by Prof. Piazzi Smyth (who also gives the length of the Kings' Chamber as 412.6 ins.) as 41.27 British inches. The height of the coffer, therefore, is one-tenth of the length of the Kings' Chamber or 2 cubits, and since $\frac{h'}{h} = \frac{5}{6}$, h' becomes equal to 5/3 of a cubit, and the bottom of the box is ⅓ of a cubit thick. No one knows what these measures, the foot and cubit, were called at the time the Pyramid was built and the coffer constructed, but it is customary at the present time to call every ancient measure between 18 and 24 ins. long a cubit, and every measure about 12 ins. long a foot.

While a coffer of more simple dimensions might have been chosen, this particular type appears to have been

selected for obvious reasons. It was required to be so large that it could not be removed and sufficiently massive to offer great resistance to destruction. Its horizontal dimensions are in feet and fractions of a foot. Its height is one-tenth of the length of the Kings' Chamber, while its depth is one-twelfth of that length, indicating the division into tenths and twelfths, the decimal system and the modern method of dividing the foot.

In order to justify the use of these measures, the following demonstration appears necessary:

The foot and cubit owe their origin, as far as the relation between them is concerned, to ancient universal symbolism; when this originated is purely conjectural and of no special importance in this discussion. If it was ever true, it is true now. Matter circumscribed by Spirit is a universal condition, symbolized by a cube (the symbol of Matter) circumscribed by a sphere (the symbol of Spirit).

In Fig. 2, let *A B D E* represent the face of a cube. In order to circumscribe this cube by a sphere, describe the dotted circle with center at *F*, the middle

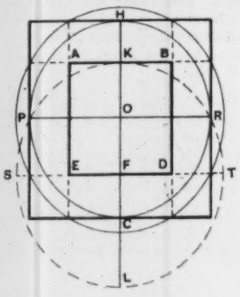


Fig. 2.

Point of *E D*, and with radius *F K*. Draw *P R* perpendicular to *F K*, then *P R* will be the diameter of a sphere circumscribing the cube of which *A B D E* is the face, since *P R* equals *F K*$\sqrt{3}$, the cubic diagonal of the cube. With *O* as a center and *O P* as a radius, describe the inner full circle. It is a great circle of a sphere circumscribing the cube.

Since the volume of a pyramid is equal to one-third of the area of its base multiplied by its height, if a square be drawn circumscribing this circle with its sides parallel to the sides of the small square, there will result a square pyramid base, since the areas of the squares are as 1 to 3 and their sides as 1 to $\sqrt{3}$. These two squares constitute a square zodiac, for if the sides of the small square be prolonged to intersect the sides of the large square, and these points of intersection be joined to *O*, the resulting twelve angles about *O* will be 30° each.

The relation of the foot to the cubit or 1 to $\sqrt{3}$, being common to the sphere, cube and pyramid, is universal. It exists in the sphere in the relation between its radius and the diameter of a circle 30° from a great circle; in the cube, in the relation between its edge and its cubic diagonal; and in the pyramid in the relation between the sides of the two squares of the square zodiac which constitutes the pyramid base. It follows, also, that the geometry of symbolism being that relating to the sphere, cube and pyramid is therefore universal.

Fig. 2 being general, let *F K* represent the radius of the earth, then with *O* as a center and a radius equal to *F K*, describe the outer full circle; letting this represent the equator, the inner full circle will be the 30th parallel, North Latitude; the two squares will be the base of a pyramid circumscribing the parallel of 30° North Latitude, projected on the plane of the equator as the earth's equatorial zodiac.

If *F K* represents the radius of the celestial sphere, and the plane of the ecliptic be substituted for that of the equator, the same course of reasoning will apply as above and a square celestial zodiac will result. Geometrically, the square zodiac precedes the circular.

The Great Pyramid of Gizeh appears to have been designed and built as a symbol of the Earth Pyramid and others; its exterior dimensions are in no way connected with those of the earth's radius or the diameter of the 30th parallel. Its base side is 440 cubits long.

The length of the cubit as determined from Prof. Piazzi Smyth's measurements of the Kings' Chamber is 20.627 British inches. This would make the base side of the Pyramid 9,075.9 ins. long. In 1880-1882, Prof. W. M. Flinders Petrie determined the length of the base sides by triangulation to be 9,068.8 ins. This would make the length of the cubit 20.611 ins. The lengths of the foot corresponding to the above cubit values are 11.91 and 11.9 British inches.

Among other places, the foot measure is found in the roof or ceiling of the Queens' Chamber; the length of the "rafter" is 119 British inches, the slope angle of the roof is 30° and the width of the room (10 cubits) is equal to the length of the rafter multiplied by the square root of 3 or 10$\sqrt{3}$. The room is 10 cubits wide and 11 cubits long. It is found, as already shown, in the coffer, and it exists in the floor of the Kings' Chamber as the "concealed measure" of tradition, where it has been trodden under foot from the beginning.

D. W. Lockwood,
Col. U. S. A., Retired.
508 Colorado Bldg., Washington, D. C., April 27, 1911.

Some Criticisms of Institutions for Higher Education: A Reply.

Sir: I have read in your issue of May 11 the address entitled "Some Conditions Affecting Higher Education," by Mr. D. W. Taylor. It will be well, I believe, to direct a little more attention to it than is done by the short editorial reference in the same issue.

I quote below a few extracts from it. While it is not always fair to judge an address by extracts without reference to the context, it will be noted that each one of these extracts contains a definite statement regarding either the students, teachers or management of our higher educational institutions. Some are given as opinions; some as facts. The writer has a right to his opinions, though in considering the value of a criticism, the mental attitude of the critic as indicated by his opinions should naturally be taken into account. The extracts are as follows:

"I honestly believe that, with the possible exception of the medical profession, there is more humbuggery among teachers than among the members of almost any other profession."

"* * * but they serve to show what are the possibilities for evil under the unbusinesslike methods upon which our institutions of higher learning are conducted."

"Only as a teacher is a man supposed to be perfect and not to need active and insistent supervision."

"Just think for a moment of the manner in which teachers are generally developed in our colleges. When a teacher is needed, some young man with certain characteristics is singled out from the current graduating class. His name is John Brown and he may have never thought seriously of becoming a teacher. The salary offered him to teach drawing or mathematics to the incoming freshmen will probably be about 70% of what he has just been offered as assistant draftsman to the erection engineer of a soap factory. * * * When he gets down to work, no experienced teacher ever comes near him to see what he is doing with his men. * * * And in the meantime Brown has learned that he can shirk this and neglect that and that no one will be the wiser. * * * Soon after Brown began to become lax in his duties, some bright wag of a student who had discerned this fact, slipped in a blank paper on his final examination under Brown and received the same mark as his classmates who laboriously worked out the subject matter."

"In my dealings with negro tracklaying gangs in the South, with railroad contractors and land sharks, I had had something to do with brutal and unprincipled men; but I have rarely met men that could vie in every attribute that was unworthy with one or two of the student representatives on their athletic committees at that time. And when I realized that these men, with all their coarseness, brutality and lack of principle, had more influence with the students than I or any other teacher, I no longer wondered that it was so difficult to break up the habit of cribbing and cheating which had such a hold on the students of that school."

"We have completely abolished drunkenness among the thousands of responsible railway employees of the country. Do you mean to tell me we can't do as much for the bright young men in our colleges?"

"Let us not only not confer our diplomas upon an educated class of thieves and toughs, but let us not confer them upon a single educated thief or tough."

"You cut your classes whenever you please and when you return your teacher welcomes you back."

"But under the conditions that now exist, it is no wonder that 90% of our engineer graduates are badly disappointed with their first year of real work."

In his address Mr. Taylor refers to the "attacks" which are being made on the colleges, and says that the few defences he has seen have been very lame ones. Such "attacks" as those quoted are not likely to improve conditions which may need correction. Broad, general, false statements are not generally supposed to be proper foundations for just criticism.

He refers to "the possibilities for evil under the unbusinesslike methods upon which our institutions of higher learning are conducted"—not some of them, mind you, but all—and he descants on the businesslike methods employed in the management of great railroads. And this by a man from the Chicago and Alton! Shade of Harriman! He does not refer to the possibilities of evil due to any unbusinesslike methods in the office of the Chief Engineer of a railroad; because these officials, of course, have business experience. Did it ever occur to him that the managers of some of the engineering schools, and many of the professors, are men with perhaps as much experience, not only as teachers, but as engineers, as he has had, and even possibly as much intelligence, though doubtless without his capacity for the higher criticism.

The salary offered in this school to a young teacher is, I believe, greater than that offered to an "assistant draftsman to the erection engineer of a soap factory." I must admit, however, that in accepting the position he must deny himself the pleasure of becoming well informed regarding this interesting article of commerce; a denial enforced by the "unbusinesslike methods" of our higher institutions of learning and which, as a stockholder, I acknowledge with pain, does not obtain in all the businesslike departments of all our railroads.

Unlike Mr. Taylor, I here emphatically point out that this is not a generalization.

Mr. Taylor insists on constant watching, check and supervision: "Only as a teacher is a man supposed to be perfect and not to need active and insistent supervision." "And in the meantime Brown has learned that he can shirk this and neglect that and no one will be the wiser."

Mr. Taylor may again be speaking from his personal experience. After an experience of thirty-six years such has not been mine. In the school with which I am connected, criticism is made by student and manager where criticism is due. And when a man is found unfit for his position he does not continue to hold it.

Luckily serious criticism is not often necessary, because the manager, in filling positions here, proceeds in a manner not referred to in the address of Mr. Taylor. He considers his time to be more valuable than that of a watch dog. Instead of securing the services of men who need constantly to be watched, he spends part of his time in obtaining those who need a minimum amount of watching. He sometimes succeeds in securing those capable of watching him! He will not soon forget the eleven-day, four-thousand-mile, bitter cold winter trip, with nights in sleepers and days of inspection which he took to obtain the last one. And the end justified the means. Furthermore, this method is applied here, not only in securing the services of teachers; it is applied to the office force and to the janitors. A janitor needs direction; when he needs watching, he gets it.

We are glad to learn from the address that all teachers are not humbugs. We bow with humility and thankfulness as we catch the hackneyed morsel, "I know very well that there are noble, self-sacrificing teachers and consecrated students in every great school." And *I* know of one professor who was a forger and of another who was hung for murder. Teachers are generally just plain men with the same aspirations as other men; and most emphatically they are not generally humbugs.

Statistics are sometimes valuable. I have heard, however, that sometimes they lie. Whether they lie or not, it is often interesting to know how they are collected when a statement of fact is based upon them by an engineer. I am now referring to Mr. Taylor's statement that "it is no wonder that something like 90% of our engineer graduates are badly disappointed with their first year of real work."

I have attended many meetings also attended by many young graduates of one school, have seen their strong faces, conscious of power and bright with hope for the future, have heard them join in the song which I venture to quote below, and somehow I never thought of collecting the "disappointment statistics" to which Mr. Taylor must have devoted a considerable period of his valuable time.

OLD RENSSELAER.

Thou hast sent us forth to labor
Old Rensselaer.
We have wrought to win thy favor
Year after year,
Steel to weld and stone to shiver,
Sink the mine and span the river,
For thine honor toiling ever,
Old Rensselaer.

When thy sons are met together
From far and near,
Scarred with service, worn with weather,
Old Rensselaer,
Proud they lay their deeds before thee,
Done to show the love they bore thee,
Stronger grown as years pass o'er thee,
Old Rensselaer.

When they write our nation's story
Splendid and clear,
Surely great shall be thy glory,
Old Rensselaer.
In their works thy sons enshrined thee,
Mighty works to leave behind thee,
Mother land, let these remind thee
Of Old Rensselaer.

And when I have seen this sight and heard this song roll forth, you must understand, Mr. Editor, how ashamed I must feel to be found among such "an educated class of thieves and toughs"; until I suddenly recollect that I, myself, am one of the gang!

Having been one of the faculty of the University of Wisconsin, Mr. Taylor in his calm, judicial review of the "Conditions Affecting Higher Education" in this country refers to it in the paragraph relating to negro gangs quoted above. He does not seem to think it his duty to make further reference to the work of the University. I never have had the honor of being connected in any way with that great school, but I will supplement his information regarding it. Its school of engineering stands in the very front rank of the great schools of engineering of the world. The University is one of the glories of that great State. It has been one of the prime factors in the development of the State. Better were it for the State that its greatest city should be blotted out than that it should lose the school which has stood for so much in its past history, which is doing so much for it at present, and which promises so much for the future intellectual and material advancement of its citizens.

We are told that educational institutions are under fire. They should be. They are not perfect. And

probably in all of them constructive criticism is welcomed. My blueprints which outline the curriculums of our courses are changed every year—changed by the constructive criticism of students and teachers. Some one has defined a fool as a person who has never made an experiment. Another definition might be, a destructive critic.

It seems that the engineering societies are forming committees to report upon the methods of instruction and conditions existing in engineering schools. I sincerely hope that these committees will study the subject carefully and intelligently and make helpful reports to us. But engineers should remember that the management of a school of engineering requires technical knowledge which is obtained only by experience. The technical knowledge required of an electrical engineer is different from that required of a structural designer; and no matter how expert either may be in his specialty, it does not follow that he is qualified to give expert advice regarding that of the other; nor does it follow that he is capable of giving valuable advice regarding the management of engineering schools. My experience has been that the views regarding the management of engineering schools, of some of the great engineering specialists, have been, perhaps naturally, warped because their experience has been limited to a great extent to their specialties.

The subject is interesting and is a broad one. But this letter is perhaps too long already, so, following the example of the post-prandial speaker, who often ends his little piece by a story pertinent or otherwise to its subject matter, I tell a tale told to me by one who heard the warning and saw the result.

To a small town, years ago, came a country circus. Under the tent flap a small boy was sticking his nose. One of the circus men standing by said impersonally something which sounded like this: "Fifdoughnutwashoutreelgetsisnoodelbuggled." He casually repeated it. Suddenly there was a withdrawal of the face of the small boy accompanied by fearful yells. There was a man inside the tent with a stick. By Jove! the small boy did get his "snoozzle bloodied."

Palmer C. Ricketts.

Rensselaer Polytechnic Institute, Troy, N. Y., May 22, 1911.

Tests of Beach Shells as Concrete Aggregate.

Sir: Recently we were called upon to design some houses at Vernon View, a newly developed salt water summer resort near Savannah, and since beach shells could be obtained there at about one-third the cost of crushed stone or gravel we decided to use such if they proved satisfactory. We could find no definite information on the reliability of such shells as concrete aggregate and so decided to make some experiments of our own.

We first built an experimental wall 5 ins. thick, reinforced both vertically and horizontally, using the regular oyster shells obtained from a local factory. We found these required a great deal of labor to work down around the vertical and horizontal rods. We also found it almost impossible to keep the shell and the mortar together; that is, when placed in the forms the mortar had a tendency to slip away from the shell leaving the shells hanging up about the horizontal reinforcing rods while the mortar would slip on down in the forms.

These "factory" shells are very uniform in size and too large for work in forms for thin reinforced walls. We found by test that the voids in the "factory" shells run about 70%.

We then got some beach shells. These are found in piles along the river banks. They are clean from the washing of the waves, and range in size from the little finger nail to the size of two fingers. We found the voids in them to be 61%. We constructed the same thickness wall, and found the mass flowed into place around the rods very nicely requiring only the usual amount of spading. The result was a reinforced wall of good density. We then made a concrete slab using these beach shells as aggregate and tested it under the stable load of cement in sacks, piled upon the full free span of the slab. Following are the data of the test:

Mixture.....1: 3.7: 6
Age when tested.....44 days
Reinforcement..⅜-in. round rods, one way 6 ins. c. to c. 0.47%
Size slab (over all).....11 ft. 4½ ins. × 4 ft. 4 ins.
Size slab (bet. supports).....8 ft. 10 ins.

Deflections: Load, lbs.	Defl., ins.	Date.
1,600	0	4/19
2,400	1/8	4/19
3,400	3/16	4/19
5,000	5/8	4/19
6,600	7/8	4/19
7,500	1/2	4/19
7,500	5/8	4/19
7,500	13/16	4/19
9,700	crack	4/20
10,400	failed	4/20

It will be noted that the load of 7,500 lbs. was left on the slab 24 hours and that the deflection went from ⅝ to 13/16-in.

The deflections are instructively of little value for the reason that they probably do not show the true deflections as the two timber supports rested on other timbers which in turn rested on the ground, and altogether the supports under the slab were not sufficiently substantial to give correct deflection information.

Savannah Engineering & Construction Co.,
Wayne Cunningham, Pres.

Savannah, Ga., May 5, 1911.

Water-Waste Prevention in New York City.

Sir: Referring to your editorial in regard to the New York Water Supply, in your issue of May 18. Some years ago I was in charge of a party making surveys for aqueducts and reservoirs for the Commission on Additional Water Supply, and can well remember my feelings when the passing of a law to prevent water from being obtained in Dutchess County rendered this work of no value. I can therefore heartily endorse all that you say against laws which prevent engineers from obtaining water as cheaply as possible, at any point from which it may be most readily brought to the city.

But it seems to me your treatment of the subject of waste prevention is inadequate. Efficiency engineering consists essentially in having an ideal, and means for determining how nearly that ideal is attained. In the present instance the ideal is a consumption of say 40 gallons per capita per day, instead of 106. From the diagram on p. 605 of Engineering News, I find that the maximum consumption was about 133 gallons per capita in 1905. If the consumption has been reduced from 133 to 106, instead of from 133 to 40, then only 27/93 or 29% of the possible waste prevention work has been acomplished.

It is a matter of experience that the consumption per capita in a community is directly in proportion to the per cent. of unmetered house service pipes. The simple reason is that as soon as a meter is placed in position, the consumer becomes his own inspector, because his pocketbook is threatened, and he is a more efficient and watchful inspector than any which the city could hire. In this short discussion it will be sufficient to answer two objections most commonly raised. The first is that people might be induced to use less water than was good for their health or complexion. This difficulty, if it really existed, could easily be removed by providing that the minimum water rate should pay for a considerably larger supply than that which the Board of Health, or other competent authority should determine was essential to health.

The second objection is that New York is a manufacturing city, and that the use of water for manufacturing purposes increases the proper consumption per capita. This is true, but Providence, R. I., is a city with probably as many manufactories per capita as New York, and the consumption in Providence, some ten years ago, was less than 40 gallons per capita.

With metered service pipes to detect waste would naturally go Venturi meters on street mains to detect leakage, but it is not necessary to complicate the calculation of efficiency of water-works management by introducing the number of Venturi meters. The efficiency of management may be considered as practically equal to the per cent. of metered service pipes.

The questions for the taxpayers of New York City to decide are:

1. Is there any inherent reason why a large per cent. of the service pipes could not be metered?

2. Is there any reason why, if say 95% of the service pipes were metered, it could not be reasonably expected that the consumption would decrease to say 40 gallons per capita?

3. Is there any reason why this saving of some 60 gallons per capita could not be made quicker and cheaper than that same amount of water could be obtained from the Ten Mile River or any other source?

4. If 60 gallons per capita of the present population could be saved, how long would it be before the probable increase in population would make it necessary to build new water works?

Winslow H. Herschel.

137 West Swissvale Ave., Edgewood, Pittsburg, Pa., May 19, 1911.

[Engineering News has been foremost in advocating the introduction of water meters for a quarter century, and one excellent result of the present danger of water famine in New York will be, it is hoped, a large increase in the number of water meters. Nevertheless, none of those who have given most careful study to waste prevention problems in New York City believe it would be possible to cut down water consumption to anything like the extent that Mr. Herschel suggests. It is one thing to measure water to a private house occupied by a small family who live frugally. It is quite another thing to measure the water delivered to a tenement or apartment house where the man or woman who uses water does not care a copper how much the landlord has to pay for it. And speaking broadly, every resident of New York City either lives in a rented tenement or apartment or else is so wealthy that he cares very little how much he wastes of water or anything else.

Of course, water meters ought to be universally introduced on the public water-supply of New York and every other American city because that is the only fair and business-like way to sell water. It would be just as reasonable for the gas companies of New York to connect their gas pipes to a building and furnish for a fixed price all the gas the occupants chose to use as it is for the city to furnish water at a fixed price and permit people to use and waste all they choose.

We hope that there may be a wholesale introduction of water meters in New York City; but we do not believe that it could be done in three months or six months, or that it would accomplish any such enormous reduction in the consumption as Mr. Herschel predicts.—Ed.]

Handling Freight at Way Landings on Small Rivers.

Sir:—In Engineering News, May 4, p. 539, there is an article, "Freight Handling Installations for Rivers Subject to Great Variations in Level," by Mr. G. C. Scherer, of Montgomery, Ala.

His cases 1 and 3 are perfectly feasible and practicable under the conditions that he states, but his case 2 does not seem to the writer to be practicable. The amount of freight consigned to way landings in general is not sufficient to warrant the expenditure of even the small amount necessary to install this simple apparatus. The writer knows of only three way landings on the Tombigbee River, from Mobile to Demopolis, a distance of 230 miles, where such an apparatus might be used to any advantage. Each of these three landings has an inclined track leading from a warehouse on the bank to low water, on which is operated a car attached to a windlass in the warehouse which is operated either by horses or gas engine.

Packet boats carry from 12 to 15 deck hands, and these men can unload the freight consigned to these warehouses, placing it on the car or near it in about the same length of time it would take to rig the cableway.

Another important point is that a packet carrying a barge would have to turn around for at least one-half of the landings to get the barge between the boat and the bank, so that the cable would lead over the barge, which is a loss of time.

Mr. Scherer's suggestion that freight could be consigned to one landing instead of several along a certain stretch of river may be all right in theory, but it cannot be worked out in practice, for the simple reason that hauling the freight from the river warehouse to the merchant's place of business, perhaps 5 to 10 miles distant from the river, has to be taken into account.

If all way landings were in small towns about 25 miles distant from each other some apparatus for handling freight might be practical.

Taking into consideration all conditions as they usually occur at way landings, it does not seem to the writer that any improvement can be made on the present method of handling freight at these landings.

Wm. Heer, Jr.,
U. S. Junior Engineer.

U. S. Engineer Office, Mobile, Ala., May 10, 1911.

Notes and Queries.

In the article on "Recommended Jobbing Shop Practice in Designing, Drafting and Cutting Spur and Bevel Gears" published in our issue of May 25, p. 630, due to a draftsman's error, Fig. 4, shows gear teeth marked 1½-in. diametral pitch, 1¼-in. diametral pitch, etc. The inch marks should of course have been omitted so that the legends would read 1½ diametral pitch, etc.

Information is desired as to the "General Association of the Engineers of America." A correspondent writes us that he was made a member of this society in 1868 at New York City, and that Mr. G. Weissenhorn was then Acting Manager-in-Chief. Our correspondent has a certificate of membership bearing the number 354. He inquires whether the society is still in existence, or, if it became defunct, what was its history.

The article entitled "Notes on Three Irrigation Projects in the Punjab, India," by Mr. A. B. Segur, in the issue of May 18, 1911, p. 585, the following correction should be noted: In Fig. 2 and Fig. 3, for "Upper Chenab" read "Upper Jhelum," and make the same correction in the tabulation of completed work on p. 588. In the formula at the top of p. 587, the last expression should be

$$x = p\left(\frac{V}{V_o}\right)^{3/2}$$

as is evident from the expression from which it is derived.

The Law Governing Diversion of Interstate Waters.*

By CARMAN F. RANDOLPH, ESQ.†

My opinion is asked whether the City of New York can acquire the right to obtain an additional water supply from interstate streams or bodies of water where the diversion would substantially diminish the quantity in an adjacent State. The query requires an examination of interstate waters generally, and, as yet, a comprehensive principle‡ in regard to their utilization has not been definitely adjudicated.

A few years ago the City of New York constructed a dam across the Byram River, a small stream flowing into Connecticut, near the State line, and diverted the water. A riparian owner in Connecticut sought to enjoin the diversion, but the Supreme Court of the United States denied his application on the ground that he had delayed acting until the city had expended large sums in the prosecution of the work. (N. Y. v. Pine, 185 U. S., 93.)

The court did not find it necessary to decide squarely important questions in regard to interstate waters argued, but its opinion leaves little room for doubt that had Pine brought suit promptly the city would have been permanently enjoined. The court said:

> We assume, without deciding, that, as found by the Circuit Court, the plaintiff will suffer substantial damage by the proposed diversion of the water of the West Branch. Also, without deciding, we assume that, although the West Branch above the dam and all the sources of supply of water to that branch are within the limits of the State of New York, it has no power to appropriate such water or prevent its natural flow through its accustomed channel into the State of Connecticut; that the plaintiffs have a legal right to the natural flow of the water through their farms in the State of Connecticut, and cannot be deprived of the right by and for the benefit of the City of New York by any legal proceedings, either in Connecticut or New York; and that a court of equity, at the instance of the plaintiffs, at the inception and before any action had been taken by the City of New York, would have restrained all interference with such natural flow of the water.

Scrutiny of the opinion shows that, but for the complainant's delay, the court would have blocked the city's enterprise by the rule of the common law that a riparian owner has a property right in the natural flow of a stream, and the rule of public law that one State cannot expropriate for its own use property in another.

The court properly ignored the ingenious argument that the property really taken was not a right to the flow in Connecticut, but was water caught in the State of New York, and therefore property in that State subject to its eminent domain. This argument clearly implies the universal right of an upper State to divert all water from an interstate stream, provided it is ready to pay compensation to all the injured individuals in a lower one. An intolerable proposition—not only perverting the common law, but ignoring that public interest which, as we shall see, is a vital element in the problem of interstate waters.

If the Pine case prefigures the whole law on this phase of the interstate water question, we may anticipate such embarrassments as these:

(1) A lake lies in States A. and B. Neither can divert a substantial proportion of its natural volume because of the resulting damage to riparian owners in the other. Nor can the State controlling the outlet increase this volume by building a dam, for this will flood land in the other State.

(2) A stream separates A. from B. Neither can divert water to the injury of a riparian owner in the other.

In each of the foregoing cases a conventional boundary line prevents two fraternal communities from enjoying valuable privileges which either might enjoy were the line shifted.

(3) A stream rises in A. and runs into B.; A. must not divert the water. Another stream rises in B. and runs through A.; B. must not divert. Here, two States, each perhaps desirous of utilizing headwaters, are debarred.

In citing these illustrations, I am not depicting a general, or even, at present, a very noticeable hardship. But here and there State lines have caused embarrassment, and with the growth and congestion of population and the enlarging use of water for motive power, embarrassments are likely to increase in number and intensity.

I do not consider such difficulties insoluble. I cannot believe that a great community, whose health and prosperity depend on its water supply, will be absolutely forbidden to satisfy its needs from an abundant and economical source merely because a petty private interest in a neighboring State cannot be expropriated and is owned by a person unwilling to sell, perhaps incapable of selling by reason of infancy or insanity.

The very statement of the rule indicated in New York v. Pine suggests a hardship at once so severe and absurd that we are entitled to look confidently for a way of escape. Conceding the correctness of this rule, in view of the status and relation of the parties to the suit, let us examine the question of interstate waters from a different standpoint. Conceding that a municipal corporation of one State can be enjoined from diverting interstate waters by an owner of property in another, let us suppose the State itself takes the initiative.

Should the State begin works for the diversion of water it could not be enjoined in a private suit, because it is not suable by a citizen without its consent. But if the State's action were not founded on a legal right it seems that the agents actually doing the work could be enjoined, on the principle that a government cannot confer authority on its agents to seize or hold property illegally.

U. S. v. Lee, 106 U. S., 196; Avery v. Fox, 1 Abb. C. C., 246.

If there be a right in the State it were better to establish it directly and not wait to prove it in defense of a private suit. It is in this direction we must look for escape from the embarrassment suggested by New York v. Pine.

In speaking of a State's right in water, I do not mean such proprietary rights in the fluid as the law recognizes. Nor am I concerned with certain State Constitutions, which declare the State itself to be the owner of all water within its boundaries. I refer to that interest in water which each State possesses as the guardian of its community. This interest is partially, but not fully, developed in adjudged cases, yet it will be found adequate for the just protection of the community. For example, I think it is clear that the right of an individual or a corporation to divert water, whether gained by public grant or by prior appropriation, is presumed to be utilized within the State, which may forbid the carriage of the water beyond its bounds.

After the right of a State has been established, the utilization thereof will be governed by the local law. For example, the State of New York, having ascertained its portion of a particular stream, may therefore authorize the City of New York to divert it upon compensating local proprietary interests injured by the diversion—the compensation not being enhanced by the establishment of the State's right, which, I repeat, is nothing more than the ascertainment of the general interest of the commonwealth.

We will first consider how a State can obtain a right in interstate water by agreement and then whether it can establish rights by legal proceedings. While a State of the Union is forbidden by the Constitution to make any "treaty, alliance or confederation" with any party, it may make, with the consent of Congress, a "compact or agreement" with another State, and it seems that consent need not always be obtained in advance (Virginia v. Tennessee, 148 U. S., 521), though, if a compact thus made traverse the rights or the policy of the United States, Congress is competent to disregard or annul it.

Interstate compacts are not common, and thus far have dealt chiefly with boundary questions; but there is no reason why they should not deal with waters, always subject to the superior federal right in respect to interstate navigation. An important question of law in this respect is whether a State may, in an arrangement with a neighbor, affect the rights of its own citizens, for it is altogether probable that an arrangement in respect of waters would affect such rights in one or both States.

Now, whatever the position of an individual whose property is affected by the provisions of an international treaty, it would seem that a State of the Union cannot, in a compact with another State, deprive a citizen of rights without compensation. But I am of the opinion that when one State makes with another a compact proper in itself, it will be usually assumed to promote a public purpose in furtherance of which it may expropriate any property required.

Already we have interstate bridges built under complementary exertions of eminent domain. The New York Court of Appeals once upheld a statute allowing a New Jersey canal company to flood land in New York State for a reservoir, on the ground that the canal was of commercial importance to the City of New York. (Townsend's Case, 139 N. Y., 171.) In an opinion of the Supreme Court of the United States it is taken for granted that adjacent States can unite in reclaiming a malarial district crossed by the boundary line. (Virginia v. Tennessee, 148 U. S., 518.) There is no stretching of principle in recognizing the ability of two States to make joint use of a boundary lake or river, or even to build a common reservoir. Nor in affirming the right of a State to gain a use in an interstate body of water by giving to its neighbor a compensatory use in another one.

While there is no legal impediment to the making of various interstate compacts in respect of waters, they are most likely to be consummated when both States are embarrassed by existing conditions and are ready to bestow benefits in order to obtain them. In the absence of conditions favorable to satisfactory agreements, a State desiring to establish a right in interstate water must forego its wish unless it can enforce a right by legal proceedings.

Noting that a proceeding must assume the form of a controversy between the States interested, we proceed to inquire whether there is a principle of law enabling the Supreme Court of the United States to grant relief. An available principle must be one common to all the States. Whatever the law of waters in the several States, the law for interstate controversies must be general. This couple of States maintains the common law rule of waters: that, the law of prior appropriation, in still another each system is represented. These local peculiarities should not influence the Supreme Court of the United States in determining controversies between States of the Union. These States are on a par before the federal tribunal. Their reciprocal rights and obligations do not depend on the incidents and accidents of local law, but are attributed to them in common as States.

Were the States of the Union independent nations, each would be in a position to use the waters within its territory without regard to the effect in other States, and it is not inconceivable that great States would abuse their power to the detriment of weak neighbors. But were the States independent, it is to be presumed that generally each would observe the principles of international law in this as in other respects.

Excepting, perhaps, some early mitigations of the conduct of war by the influence of Christian teaching, it might not be amiss to say that our whole system of international law originated in water. The uncertainties and perils of intercourse by sea slowly brought about the institution of common rule for merchant adventurers, and finally the complete freedom of the sea was assured to all vessels flying a national flag.

Hindrances to the navigation of international rivers long survived the proclamation of the law of the open sea, but to-day these rivers, generally, are open to the merchant ships of all riparian states and of states in intercourse with them.

At present the international law of waters relates chiefly to navigation, but whenever the use of watercourses for drainage, or their diversion for canals or for consumption, irrigation or power causes injury in another country, controversies will arise, and from these controversies we must look for the formulation of principles for their adjustment.

Surely the pollution of a river to the serious detriment of a neighboring country would be a substantial grievance. If works in one country should impair navigation or flood property in another there would be just cause for complaint. (Vattel, I., ss. 271-3.) The United States once complained of an obstruction to the flow of a stream in Maine caused by acts done in Canada. (Wharton's International Law Digest, s. 20.)

In regard to the diversion of water by an upper riparian nation, Calvo suggests a broad principle when he says: "The river or the stream which flows from a lake cannot be impeded at the outlet by the proprietor of the soil on which the lake terminates. (*Droit International*, 5th ed., I., p. 467.)

For some years the United States and Mexico have complained of each other in respect of diversion from the Rio Grande. A joint commission has been appointed to investigate the subject of diversion among others. An international dam and reservoir is proposed for effecting an equitable distribution of water. It seems that a suit brought by the United States to enjoin a private company in New Mexico from diverting water to the injury of navigation—a suit not yet finally determined by the Supreme Court (U. S. v. Irrigation Co., 174 U. S., 690; 184 U. S., 416)—was begun by the Department of Justice after receiving from the State Department a communication prompted by complaints from Mexico [See proceedings of the International (Water) Boundary Com., I., p. iii. (1903)]. And the Supreme Court has recognized the interest of Mexico in the suit, though not a party to it. (184 U. S., 420.) Everything points to the recognition by each country of mutual obligations in regard to this international river, and it is not unreasonable to anticipate an adjustment according to principles of international law.

When international controversies over water supply become sufficiently frequent to attract the sustained attention of publicists we shall have a general declaration that a nation is not justified in dealing with international waters in entire disregard of its neighbor's welfare. In respect of diversion, we may anticipate the presumption that a nation is not justified in diverting the entire flow of a stream from its neighbor.

If international law stopped here it would not accord to an upper country any benefit from an international stream, apart from the riparian right, wherever a use beyond this right would sensibly diminish the flow in a lower country.

If the law stopped here it would burden the upper country with a unilateral and uncompensated obligation in favor of the lower one, and the country in which the stream reaches the sea would be entitled to receive the water intact and divert it at pleasure.

---

*An opinion rendered Jan. 20, 1904, to the Merchants' Association of New York City on the question whether the city can obtain an additional supply of water from interstate rivers.

†26 Liberty St., New York City.

‡Some advance in the definition of principle has been made since this opinion was written, but a comprehensive definition is still lacking and the practical questions are for the most part hardly touched; yet the field is capable of most useful development if the legal questions be properly handled.—C. F. R.

Now the whole system of international law is so dependent upon mutuality of rights and duties that any opposite obligation is presumably excluded. When we say that a state has no right to deprive another of all the water of an international stream we evidently have not completed an equitable proposition.

I have long thought that an earnest controversy over water supply must lead to the enunciation of an equitable principle to be thereafter commended to diplomatists and accepted by arbitral tribunals, and some months ago I suggested what I believe is the foreshadowed doctrine of international law. (Interstate Waters, *Columbia Law Review*, May and June, 1902.)

My proposition is this. An upper state is not bound to deliver to a lower one the natural volume of a stream lessened only by ordinary riparian uses. It is entitled to divert a part to other than these uses—municipal supply, irrigation, power, etc.—without regard to the effect of diversion in the lower country. In short, each state has a proportional right to the distributive use of waters rising in or flowing through its territory.

In presenting this proposition, I have no definite rule of apportionment to suggest. Indeed, none is likely to be forthcoming. Each controversy will present peculiar circumstances.

Nor am I willing to affirm the universality of the proposition. There may be cases where well-watered States should not withold any portion of particular streams from needy neighbors. Conversely, the necessities of the upper state may justify the witholding of all the water from a state when the latter's supply is abundant.

For the moment I am simply interested in demonstrating the presumptive existence of a proportional right in international law.

What of legal controversies over water between States of the Union? None need be contemplated in respect to interstate navigation. This is within the control of Congress. A State has no right to impair it. We are not concerned with conflicting claims to territorial jurisdiction over waters, or lands under water, nor to rights of fishery. We are interested chiefly in controversies regarding the distribution of water.

Were all State lines obliterated, there would be no jurisdictional controversies of a domestic nature over waters. The entire control of the waters of the republic would be vested in Congress. Were the federal bond broken, each State would be an independent nation, with a moral duty to respect the principles of international law. In fine, were the States amalgamated, an equitable distribution of waters throughout the republic would be legally possible. Were they dissociated, the principles of international law would be commended to each one.

These fanciful contingencies suggest the conclusion that while our fraternal communities may here and there fail to attain the broad utilization of waters attainable in communities ruled by a single government, they must be better ruled in this respect than rival nations, because they are impressed with a common nationality. Indeed, if not better, they might be worse off, since none can promote its just interests by force, nor, without the consent of Congress, by agreement.

The conclusion is strengthened by the reflection that in some aspects our interstate boundaries are of a conventional nature. The historian may draw interesting distinctions between the original States, and Texas gaining statehood by annexation to the republic, and the remaining States carved at pleasure by Congress out of federal territory. But, in dealing with such a subject as the water rights of the States, the lawyer takes no account of how this one became a member of the Union, or of what might happen to that one on a dissolution of the bond. Impressed with the present equality of each State, with respect to every other and before the federal government, he must view their boundaries, generally, as marking the convenient sub-division of a vast territory for certain purposes of local government. In dealing with this subject he must treat interstate lines as drawn by a political surveyor acting in behalf of a nation.

A notable result of this method of delimination is that, excepting where great rivers and lakes offer boundaries too obvious to be ignored, what may be called the natural method of boundary running is commonly discarded for the straight line of convenience. Streams and ponds are bisected. The main sources of supply for one State may lie wholly within another. In short, the lines are largely drawn without reference to the economical apportionment of water among the commonwealths.

When States are thus delimited by politically convenient lines, it is reasonable to hold that physical inconveniences caused by these lines should be susceptible of mitigation whenever this can be accomplished without attaining the proper measure of sovereignty assured to each State.

And when we point out that each State holds all the property in its territory free from the eminent domain of another and cannot be compelled to surrender its property to another in any way, I think we approximate the irreducible measure of sovereignty in this relation. Assured of this measure, the States justly and safely authorize the Supreme Court to adjudicate outlying questions by equitable principles.

An Australian controversy is extremely interesting in this relation. Diversion of water from intercolonial rivers has long been a source of contention, and it seems that a desire for a central authority for the regulation of water was one of the moving causes for union. The Constitution of the new Commonwealth provides: "The Commonwealth shall not, by any law or regulation of trade or commerce, abridge the right of a State or the residents therein to the reasonable use of the waters of rivers for conservation or irrigation." The right to a "reasonable use" imports the prohibition of an unreasonable one. In other words, the rule of proportional right is clearly implied. The Supreme Court of the Commonwealth seems competent to enforce the rule in a controversy between States, and the Interstate Commission on Trade and Commerce provided in the Constitution has a broad jurisdiction in respect of interstate waters.

That our Constitution contemplates the existence of reciprocal rights and duties of a legal nature in the several States is made plain by the provision authorizing the Supreme Court to take original jurisdiction of controversies between them. A proceeding under this provision is usually instituted by filing a bill in equity with the leave of the court, which is only refused where want of jurisdiction is apparent. Thus far there have been but two interstate suits of direct interest in this discussion, both lately brought and neither yet closed by final decree. The first is Missouri v. Illinois, 180 U. S., 208, where the court maintained the legal right of a State to enjoin another from polluting a stream to the danger point, and will make a final decree upon receiving evidence regarding the real effects of the acts complained of. This decision accords with the principle of international law.

Occasionally the matter of diversion of interstate waters has attracted the attention of States. In 1885 the Pennsylvania Legislature requested an opinion from the State's Attorney General as to the right of New York to divert water from the Chemung River for supplying the Chemung Canal to the detriment of the North Branch Canal in Pennsylvania. The Attorney General pronounced the action of New York illegal (4 Am. Law Reg., 384).

In 1883 the New Jersey Legislature authorized the Attorney General to institute suits to prevent interference with the flow of streams into New Jersey from other States (Laws 1883, 321). And in 1884 it authorized the Governor, with the advice of the Attorney General, to communicate with New York in regard to "the control of water flowing into New Jersey from that State" (N. J. Laws, 1884, p. 354). In 1895 the New Hampshire Legislature passed a resolution substantially like the New Jersey statute of 1883 (N. H. Laws, 195, p. 366).

Probably a search of State statutes would disclose other instances, but not until 1901 was a suit brought in the Supreme Court.

In Kansas v. Colorado, 185 U. S., 125, the Supreme Court entertained a bill praying that Colorado be enjoined from diverting an excessive quantity of water from the Arkansas River. "Without subjecting the bill to minute criticism," said the court, "we think its averments sufficient to present the question as to the power of one State of the Union to wholly deprive another of the benefit of water from a river rising in the former, and, by nature, flowing into and through the latter, and that, therefore, the court, broadly speaking, has jurisdiction."

In this case, as in Missouri v. Illinois, the court withholds final decree until it shall be informed of actual conditions. But whatever the decree, the court has established a notable precedent by taking jurisdiction of an interstate controversy over the use of water. We are entitled to assume that in each controversy of this sort it will exert its broad and flexible powers to secure susbtantial justice, an end surely attainable, in view of the great storehouses of jurisprudence at the court's command. "Sitting, as it were, as an international, as well as a domestic tribunal," said the court in Kansas v. Colorado, "we apply federal law, State law and international law as the exigencies of the particular case may demand."

In Kansas v. Colorado, a lower riparian State seeks to enjoin an upper one from diverting an excessive quantity of water. Should an upper State wish to establish a right to divert it will bring a friendly suit against the lower one by bill in equity savoring of a plea for partition.

A suit of this kind is suggested by the question submitted for my opinion, and the method of adjudication will now be considered, remarking, however, that whether an interstate controversy over the use of water is brought before the Supreme Court by bill for injunction or by bill for partition, the court will determine the broad issues by principles of equity generally applicable to either form of suit.

In the first place, we may anticipate that the court will view the controversy as primarily between political communities and, ignoring for the moment particular proprietary interests, will found its judgment upon an equitable appraisement of the interests of the respective States.

With State interests in view, the court will undoubtedly approach the case with the general presumption of international law that an upper country is neither entitled to divert all the water of an international stream, nor yet obliged to deliver all to a lower one—the presumption of proportional right. But this presumption may not always hold good. It may appear that a lower State will suffer no real injury by the diversion of all the water of a particular stream by reason of its having an abundant supply from other sources. On the other hand, the diversion of any substantial quantity might inflict irreparable injury to the lower State, while serving the mere convenience rather than the necessity of the upper one. In either case an apportionment would be inequitable; the upper or the lower State should have the benefit of all the water.

Anticipating an objection that application of the rule of proportional right might result here and there in diminishing a supply of water already appropriated to public use, I suggest that where a certain allotment of water would seem to be appropriate under natural conditions, but one of the States has already diverted to public use—a city supply, for example—a larger quantity than it would be entitled to enjoy under this allotment, the Supreme Court ought to treat the established use as an equitable possession. In this case a doctrine something like the law of prior appropriation should be applied.

In adjudicating an interstate water controversy, the Supreme Court may find it expedient to frame a decree granting relief to the complaining State upon certain conditions.

Where the diversion of water from a particular stream may be entirely or partially offset by compensating works, permission to divert may be conditioned upon the maintenance of such works. Among the matters on which the court desired information in the Kansas-Colorado case were "the possibilities of the maintenance of a sustained flow through the control of flood waters."

A broader scheme of compensation may be approved, based upon an examination of all the waters common to the two States. A state may be permitted to divert the waters it desires, provided it assures to its neighbor equivalent rights in other waters.

I have said that in determining the broad rights of a State in interstate waters the Supreme Court will not be trammeled by proprietary interests in another State. At all events, this will be so where the aggregate of these is not sufficiently large to constitute a substantial interest of the commonwealth. But where such interests will be injured by a diversion we may assume that a right to divert will be conditioned upon compensating the owners in such sum as shall be awarded by an impartial commission. This procedure would accomplish indirectly a result forbidden as we have seen by direct expropriation; but as an equitable incident in a comprehensive adjustment of interstate claims it would be, in my judgment, unimpeachable.

If, in determining the question of compensation, it could be maintained that, in apportioning water, the court simply announces an allotment which, in theory of law, has always defined the rights of the respective States, proprietary interests in each State might be treated as subject from the beginning to the claim of the other, and to this extent permissive and not entitled to compensation. This theory will not support a broad rule. While an apportionment is based upon a pre-existing principle, until it is reduced to terms it is too unsubstantial to afford a general reason for deprecating the value of established interests. Indeed, I have pointed out that the Supreme Court might equitably allot all the water in a stream to an upper State, in which event adherence to this theory would lead to the absurd conclusion that riparian owners in the lower one never had any rights whatever.

Possibly there may be cases of diversion so flagrantly violative of the welfare of another State as to call for an exceptional denial of compensation, but as a rule we should anticipate a liberal definition of vested interests.

An equitable distribution of interstate waters under the high and impartial auspices of the Supreme Court would be a novel, but not a startling, proceeding. This principle commended by the law of nations should find readier acceptance in the jurisprudence of our fraternal States, and its application is better assured among these States whose justiciable controversies are determinable by a constitutional court than among the nations, whose differences are adjusted by force or diplomacy or by voluntary submission to an arbitral tribunal.

It is to be expected that the final opinion in Kansas v. Colorado will affirm the principle, whatever the form of the decree; and the principle, once affirmed, may be as well invoked by a State wishing to establish title to a beneficial use of water as by one praying injunction against diminution of its share.*

Affirmance will render a timely service. Apart from the public right of navigation, our common law of

*Kansas finally lost the case because she could not prove actual damages.—C. F. R.

waters has been largely influenced hitherto by considerations of private riparian right—rights of access and wharfage, the watering of stock, the mill use, etc. But public needs outrank these private uses, and when a State has within its territory water available for these needs (and the matter of expense is a prime factor of availability), it would be intolerable to permit the owner of a riparian right on the other side of a conventional boundary line to obtrude his petty interest in bar, especially as he can be assured of compensation for its destruction.

I have examined the submitted question in the light of principle, and it only remains to return a specific answer.

Regarding interstate compacts, in respect of the use of water, I am of the opinion that there is no legal impediment to the making of beneficial arrangements of this sort, assuming that none will be detrimental to federal interests. For example:

(1) New York and Connecticut agree to create a joint reservoir impounding the waters of Ten Mile River and the headwaters of the Housatonic by means of a dam in Connecticut.

(2) New York and New Jersey agree to create a joint reservoir impounding the sources of the Wallkill by means of a dam in New York.

In each case the proportion of expense to be defrayed by the respective States, and the proportion of water each shall be entitled to draw, will be determined in the compact, which in its final shape will be recorded, like all interstate compacts, in the statute books of each State and be thereafter subject to construction by the Supreme Court of the United States.

Two States having thus made a compact capable of promoting the public needs of each, a person in either whose property is required in order to carry out the undertaking should not be permitted to raise the question as to the legality of its condemnation by alleging that the property is not really required for the sole, or the sufficient, public use of the expropriating State. When the destination of property to the public use of a State is established, the courts will accept this as full justification for condemnation and will not inquire into the degree of utility.

When two States, assured of fundamental rights, are ready to negotiate for their enjoyment, the question of method will be found susceptible of a lawful and fair solution.

One cannot speak with assurance of the outcome of interstate negotiations, and while in my judgment the possibility of beneficial agreement is worth considering by the State of New York, whose chief city is in need of an additional supply from economical sources, there is reason to suppose that substantial relief can be obtained by filing a bill in equity in the Supreme Court against a sister state for the ascertainment of New York's equitable rights.

In 1899 the Merchants Association were advised by their committee on legislation that an attempt to supply the City of New York from an interstate stream could be enjoined. Assuming as the committee did that the question depended on the common law their advice was sound. They anticipated the rule since indicated in New York v. Pine. Approaching the question from the standpoint of a state seeking to establish a right in interstate waters, I turn to interstate law and reach a different conclusion.

Taking for illustration the Ten Mile River, which rises in Connecticut, runs its principal course in New York, and returns to Connecticut, I am of the opinion that the State of New York can establish a right to divert a substantial portion of this stream upon such equitable conditions as the Supreme Court shall determine. Assuming that the Supreme Court would frame its decree upon a comprehensive view of the relative needs of the states in controversy it is not impossible that New York could substantiate an equitable claim to practically the entire flow.

I have sought only a legal solution of the interstate water problem. My opinion goes no further than this—The City of New York has lawful opportunities for obtaining an additional supply from interstate waters.

Whether lawful opportunities will lead to substantial benefits? In what direction and by what means the best results may be attained? are questions for future consideration.

Mine Fires.*

By HERBERT M. WILSON,† M. Am. Soc. C. E.

Fires in mines are a far greater menace to life and property than is generally appreciated. Two of the most serious disasters in coal mines within the last two years—one at Cherry, Ill., and the other at Pancoast Mine, near Scranton, Pa., originated from trivial causes. Two of the most destructive disasters in metal mines in the last year—Tonopah, Nev., and Copper Hill, Tenn., resulted from similar causes. At Deadwood, S. Dak., $1,000,000 has been spent in fighting a metal mine fire.

Moreover, there are fires raging in coal and metal mines in various parts of the country, which, having gotten beyond control, have burned for many years, devouring hundreds of thousands of tons of coal and miles of mine galleries. Of these fires, one near Carbondale, Pa., has burned out such a vast area of anthracite coal in the past ten years as to result in subsidence of the surface and destruction of surface property. Near Summit Hill, Pa., a fire is estimated to have destroyed $26,000,000 worth of coal after burning 51 years. Near Jobs, Ohio, a tract of coal valued at several million dollars has been burning since 1884.

In some of the deeper metal mines at Butte, Mont., fires have been burning in the old mine timbers since 1889. In the Comstock vein in Nevada, thousands of feet of tunnels which had been opened and timbered at great expense are being burned out, causing falling of the roof and dislocation of the metal-bearing vein—thus rendering future recovery of the ore difficult if not impossible.

On the afternoon of Nov. 13, 1909, the Cherry (Illinois) mine was fired with the result that 262 lives were lost and the property seriously damaged, in addition to the damage assessed upon the owners for the benefit of the families of those who perished. The evidence indicates that the fire was caused by a pit car loaded with several bales of hay intended for the mule stable in the third vein. It is believed that this car was placed under or in contact with a blazing torch or open miner's lamp placed to give light to the cagers. Possibly the oil, which was kerosene, dropped from the torch to the hay. However, the hay was fired and there being an air current having a velocity of 700 ft. per min., the overhead timbers, man-way and air shaft were quickly fired. This effectually shut off ingress and egress to the mine and imprisoned within it 484 men who were at work in the mine at the time. The cost of this fire was about $1,000,000 of which $50,000 a day was spent in direct fire fighting for many days.

On April 7, 1911, a fire was started in the Pancoast mine near Scranton, Pa., which resulted in the loss of 74 lives, leaving 45 widows and 137 dependent orphans; as well as causing the destruction of much valuable property. This fire is known to have started in an underground room, presumably from some oil-soaked waste which fired some boxes and other inflammable material carelessly left near.

The fire was not thought serious until it had been burning two hours. This delay was, in large measure, responsible for the great loss of life. A fire started Feb. 22, 1911, in the 1,166-ft. level of Belmont mine at Tonopah, Nev., which resulted in the loss of 17 lives and partial destruction of the property.

The London mine of the Tennessee Copper Co. was fired on Nov. 29, 1909, by sparks from a shifting engine igniting the top house. Embers fell down the shaft and the smoke and flames imprisoned 54 men who were later rescued. Much damage resulted to the property.

It is evident from the above that most mine fires have their origin in trivial causes, which, were proper means at hand and proper fire rules in force, might be quickly extinguished.

The nature of the combustible material found in metal mines offers varying but usually good opportunities for the spreading of a fire. While the progress of a fire might, at first, be slow, in some cases it may spread quickly and involve a large area and result in tremendous damage if not promptly extinguished.

A careful study of the origin, history and methods of combating nearly all of the mine fires which have occurred since the creation of the mine accidents division of the Geological Survey in 1907, and its present successor, the Bureau of Mines, has been made by the mining engineers of the latter organization.

It is believed from this study that the introduction of comparatively inexpensive fire-fighting appliances, the adoption of proper regulations, and the institution of a reasonable system of fire drills may minimize fires and confine others to a brief period of time with little damage to life and property.

Among the most fruitful causes of mine fires studied in the above period are, in approximate order of importance, the ignition of timbers, wooden stoppings, and brattice cloths; hay or oil-soaked materials by open torches; the ignition of coal by blown-out shorts or explosions of fire damp or coal dust, or the improper use of explosives. Surface fires communicated to the mine through the shaft or tunnel; underground furnaces and boiler plants; ignition by friction on oily, wooden rollers or rope haulage-ways, fires occasioned by spontaneous combustion of coal, timber or greasy waste.

The engineers of the Bureau of Mines have adopted as the most effective means of exploring and in the earlier stage of combatting mine fires, the use of the oxygen helmet. This is an apparatus which entirely protects the head, and through which air is furnished artificially—thus enabling the wearer to explore the vicinity of a fire under conditions of smoke [illegible] which would render his approach otherwise im[illegible]

By the use of such apparatus a number of fi[illegible] within the last few years, been promptly ex[illegible] which would doubtless otherwise have spread [illegible] haps extended beyond control. The Bureau o[illegible] encourages the treatment of wood and brattice [illegible] and other inflammable materials with fire-proofing [illegible] stances. Chemistry, through the quick analy[illegible] gases sampled at frequent intervals in the neigh[illegible] of the fire, has proven a most useful adjunct i[illegible] ing fires. By this means it is found possible to [illegible] the fire and by pumping in carbonic acid or sm[illegible] it with water, to determine by the progress [illegible] analysis, the condition of combustion; thus asc[illegible] with assurance the time when the fire may h[illegible] extinguished or may call for further combattin[illegible]

To a body of men familiar with the subject [illegible] are it seems unnecessary to call attention to [illegible] cessity of providing at each mine ample stor[illegible] plies of water under proper head and prope[illegible] veyed in protected pipes to possible danger po[illegible] the desirability of employing larger amounts [illegible] inflammable material in place of wooden min[illegible] ing or wooden doors; the proper regulation of [illegible] posal of waste; cleanliness, whereby grease [illegible] soaked material shall not be permitted; proper [illegible] tion of steam pipes and boiler plants to insu[illegible] insulation; fire-proof man-ways and air shafts [illegible] fire protection and the use of non-inflammable [illegible] so far as possible in all top works and other [illegible] structures within 50 to 100 ft. of the main ope[illegible]

Aside from these well-known measures there are others which the engineers of the Bureau of Mines would suggest, such as careful examination of the work[illegible] face after firing each shot; keeping barrels of w[illegible] or boxes of sand convenient to points at which explosives are being used; keeping open lights away from the working face for some time after firing the shot; disconnection of electric wires before shot firing; proper attention to all electric wires and their insulation at danger points; examination of the manner of liberation of explosive gases; use of safety lamps or lanterns instead of open lamps in the neighborhood of all inflammable materials when engaged on repairing wooden stoppings or examining for air leakage, etc. A proper system of fire alarm signals should be installed in every mine and should be tested at suitable intervals and underground employees should be familiar with the signals through frequent drills. The water-supply for mines is usually such as to render desirable the use of nozzles of as small diameter as 1½ and ¾-in. As high pressure as is reasonably attainable, say not under 50 lbs. per sq. in., should be furnished, for the reason that the trajectory of the jet of water must be very low, since the hose must be used in tunnels often under 5 ft., and rarely over 6 or 7 ft. in height. In consequence, the nozzle can be elevated only at a very low angle and the jet can be thrown a comparatively short distance: by test under 20 lbs. pressure only 23 ft.; under 30 lbs. pressure, 30 ft.; 40 lbs., 34 ft.

From the foregoing it is evident that the question of mine fires, their causes, possible means of prevention, and combatting is one well within the province of the Bureau of Mines and one which demands the serious attention of all persons concerned in the operation of mining property or in the protection of insurance of property against fire.

*A lecture delivered before the National Fire Protection Association at its annual meeting in New York, May 25, 1911.

†Chief Engineer, Bureau of Mines, Pittsburg, Pa.

LARGE DUPLEX ARTICULATED LOCOMOTIVES, which are four-cylinder simple engines, are being built by the Vulcan Foundry, Newton-le-Willows, England, for the Mexican Railway. They are of the Fairlie type (which is used extensively in Mexico), having two six-wheel steam trucks and two boiler barrels extending from a central firebox with side fire doors. Water tanks and fuel bunkers are mounted on each boiler. The engines are of standard gage, and are designed to haul train loads of 300 tons up grades of 4% combined with 330-ft. curves. They are arranged to burn either coal or oil fuel. The principal dimensions of these double-end engines are as follows:

Class	0-6-6-0
Driving wheels (12)	4 ft. 0 ins.
Wheelbase, rigid	9 ft. 3 ins.
Wheelbase, total	35 ft. 6 ins.
Weight in working order	138 tons
Weight per axle	23 tons
Cylinders (4)	19 x 25 ins.
Valve gear	Walschaerts
Boiler, diameter (2 barrels)	5 ft.
Working pressure	185 lbs.
Heating surface; tubes	2,679 sq. ft.
Firebox	245 sq. ft.
Total	2,924 sq. ft.
Grate area	47¾ sq. ft.
Tractive force (at 90% boiler pressure)	62,610 lbs.
Tractive force (at 75% boiler pressure)	52,176 lbs.
Ratio of tractive force (90%) to adhesion	4.4
Ratio of tractive force (75%) to adhesion	5.5
Coal in bunkers (both boilers)	4,500 gals.
Water in tanks (both boilers)	8 tons
Height to center of boiler	7 ft. 10 ins.
Height to top of smoke-stacks	14 ft. 0 ins.
Length over all (over pilots)	58 ft. 2 ins.

The Fire Waste in the United States.*

By WALTER L. FISHER.†

If the Government should suddenly lay an annual tax of $2.51 on every man, woman and child in the United States on a promise of spending the money for some useful purpose, that promise would not avail against the storm of protest which would be aroused. Nevertheless, a tax which in the aggregate amounts to that is being paid by the people of this country. It is the annual fire tax of the nation upon buildings and their contents alone. It is expended not in productive enterprise, but in destruction, and an even larger sum is annually expended upon fire protection and insurance premiums. Not only is this property loss paid by our people, but, in addition, annually 1,500 persons give up their lives, and nearly 6,000 are injured in fires.

The actual fire losses due to the destruction of buildings and their contents amounted (in 1907, the latest year for which statistics are available) to $215,084,709, a per capita loss for the United States of $2.51. The per capita losses in the cities of the six leading European countries amounted to but 33 cts., or about one-eighth of the per capita loss sustained in the United States.

Added to these figures are those which tell of the destruction which our carelessness has permitted among our natural resources. Last year 76 men employed by the National Government lost their lives in fighting forest fires in 1910. Nearly five million acres of national forest land were burned over—an area greater in extent than the whole state of New Jersey. The loss by fire in the national forests alone last year amounts to the appalling sum of more than $26,000,000.

A comparison of the average annual cost of maintaining fire departments in European and American cities indicates that the cost in European cities is 20 cts. per capita, and in corresponding cities in the United States, $1.53 per capita, or 7½ times as great.

I have been asked what, in my opinion, the National Government could do which might result in benefit to the citizens as a whole in securing a reduction in the enormous and disproportionate loss by fire in the United States. I would answer that Uncle Sam first of all should set the example by properly protecting that which is his.

The United States Government is the owner of buildings costing more than $300,000,000, and is spending each year more than $20,000,000 in new buildings. It is the policy of the Government not to insure its buildings against loss by fire, but to reduce the risk of fire. Did it insure, its annual premium would amount to more than $600,000. Calculating that it can take no unnecessary risk in these buildings, the Government, through its scientific bureaus, has made searching investigation into the combustible character of materials for use in construction work, and these investigations have not only been of immense value to the Government but, as their results are free to all, have benefited the whole country.

To state them briefly, these results have attracted attention to the necessity of developing cheaper fireproof materials, so that property owners may be encouraged to construct buildings that will better resist fire, and they also have shown the necessity of better building codes in cities, and especially of a better enforcement of the codes already enacted if the present great fire losses are to be diminished. Investigations point to the fact that fireproof buildings will be constructed at less expense in the future than in the past, and that the difference in cost between fireproof and inflammable buildings will soon cease to be an encouragement to flimsy construction.

The National Government is proceeding also to minimize possibilities of fire in the national forests, the national parks, and the Indian reservations by more effective regulations—among them, regulations to check the starting of blazes by sparks from locomotive smokestacks.

A number of the states have enacted fire-marshal laws during recent years. In one or two states we find measures covering the instruction of children in public schools on these topics. The question of fire inquests has been agitated in some sections, the idea being to attempt to fix the cause and blame of fire losses, similar to the practice in Germany where investigations of this sort follow from a tenant to owner, from owner to architect, from architect to builder, until the responsibility finally is determined. In the western timbered states very excellent laws are being worked out for the prevention of forest fires, but not yet have those states fully awakened to the necessity of making adequate appropriations for fire patrols of private or state-owned forest lands. State fire-marshal laws should be found in more states than at present, should be more comprehensive and should be more rigorously enforced, particularly with a view to covering the needs of the rural districts.

The Baltimore conflagration and the San Francisco disaster gave an impetus to the movement toward fire protection in cities, where possibly we are relatively weakest of all.

Investigations which have been made by the National Board of Fire Underwriters have focussed attention on one of the sources of failure, and that is, partisan politics in municipal fire departments. Wherever the tenure of office of responsible heads of city departments of public safety is not dependent upon election returns, the best results seem to have been achieved. In other words, where appointments of fire chiefs and fire marshals and firemen are dependent on merit rather than on political contingencies, the public receives a larger measure of protection. Men fully equipped for administrative duties in connection with fire departments and inspection forces cannot usually be obtained where tenure of office is limited to a period of two or four years.

When we consider the fact that our greatest losses in property and life by fire are within the cities, it becomes evident that we must look to the municipal governments chiefly for bettering conditions. It is estimated by the Geological Survey, from the statistics at hand, that nearly one-half the value of all the new buildings constructed in the cities of the United States within one year is destroyed by fire. The reformation can be accomplished only by constant and consistent work for the passage and enforcement of improved building ordinances; for the perfection and carrying into effect of comprehensive plans for the removal of conflagration conditions; for the upbuilding of departments of public safety fully equipped with modern apparatus, and administered by trained and permanent forces; for the enactment and enforcement of ordinances which will safeguard explosives and combustibles; and for the installation of separate high-pressure water systems for fire service where conditions warrant.

To arouse the people against the fire foe is our task. The average American citizen would admit that our fire waste is in the nature of a national disgrace. The task is to make him do something to remedy conditions. You must popularize your movement, and create a general demand for adequate laws and thorough enforcement. Let the people once realize the exact facts of their own negligence, and they will be swift to provide the remedy.

*An address given before the National Fire Protection Association at the annual meeting in New York City, May 24, 1911.

†U. S. Secretary of the Interior.

Annual Convention of the National Fire Protection Association.

The fifteenth annual convention of this association was held at the Waldorf-Astoria Hotel, New York City, May 23 to 25 inclusive. The Association has been particularly active during the past year and this meeting was acknowledged to be the most enthusiastic convention the Association has yet held. It was attended by several hundred delegates representing the 92 Associations which form the active membership, and by many associate members. From an original association of fire insurance underwriters, the membership has now expanded to include such organizations as the American Institute of Architects, the American Institute of Electrical Engineers, the National Association of Cement Users, the Royal Architectural Institute of Canada and many others.

The meeting opened on Tuesday morning, May 23, with an address by Mr. W. H. Merrill, President of the Association for the past year. Mr. Merrill's address is printed on another page of this issue.

The reports of the Association's Committees on Devices and Materials and on Automatic Sprinklers were read and adopted without modifications. The discussion over the next report, that on fire protection coverings for door and window openings, was chiefly on the fire resisting qualities of wire-glass as a window covering. The report was adopted without essential change. The Committee on Building Codes had no recommendations to make.

The Committee on Fireproof Construction submitted an interesting report which aroused considerable discussion. Mr. E. T. Cairns, Chairman, stated that the fire records of the past year had proved conclusively that entire concrete buildings were to all intents fireproof; but emphasized the point that they were by no means proof against the destruction of the lives of their occupants or of their contents. Such fires as that of the Asch Building, New York, proved that although the building might be uninjured, the loss of life might be very great. He said that the chief points in concrete construction were to provide a means of escape for the occupants and a means of making the floors waterproof. The Committee was not prepared to state the best methods of accomplishing this latter end, but stated that drains and scuppers should always be provided for each floor to carry off the water, either to the outside of the building or to the elevator shafts. Unless this is done the damage by water on the floors below from a small fire may amount to many times the actual fire loss. More attention should also be paid to means for extinguishing incipient fires.

The report of the Hose Committee was printed and distributed in pamphlet form containing some 30 pages. Specifications are given for the quality of rubber lining and cotton fabric, and the limiting values for elongation, twist and warping of entire hose under pressure. Tests and specifications for couplings are included. There are about 13 pages of specifications for the construction and care of hose for fire department use; founded essentially on the rules and requirements formerly recommended by the National Board of Fire Underwriters. Blank forms of contracts for the purchase of hose and equipment under these specifications are added. The report stated that tests at the Underwriters' Laboratories covering most of the better known brands of hose, even of the brands enjoying the best reputation, showed that the quality is inferior and the trend is downward; that there is a particular scrimping in the quantity and quality of rubber in use. The report was adopted after a short discussion.

The Committees on Hydrants and Valves and on Pumps had little new matter to report. Some slight modifications were made in the specifications for pumps, but these were mainly on minor details. The Committee on Private Fire Mains and Standard Hose Couplings reported nothing new. The first day's session closed with an address by Mr. Charles E. Meek, Secretary-Treasurer of the National Association of Credit Men. Mr. Meek told of the work of his association in impressing upon business men the seriousness of the question of fire prevention, and a sense of their individual responsibility for the country's fire waste, and in dispelling the prejudice which the buyer of insurance has too generally had against those who make insurance their business. In the evening a banquet was tendered the Association by its host, the Insurance Society of New York.

On Wednesday morning the Committee on Cold Storage Warehouse reported nothing new. The Committee on Automobile Garages submitted a short report, covering the construction of the building, its equipment, the distance from other buildings and the methods of storing and handling gasoline. Considerable discussion followed the reading of this report, especially on the provisions regarding the storage of gasoline. One of the provisions of the report was that no garage shall be nearer than 5 ft. to the side of any building, except the dwelling of the owner of the garage. The report was adopted with several suggestions which were referred to the committee.

The report of the Committee on Common Causes of Fires dealt mainly with the work of the committee and the Association in sounding public warning as to special fire risks, such as those occurring during the Christmas holidays, on the Fourth of July, and from matches and defective chimneys and flues, which cause a large proportion of fires. The discussion also took up illuminating gas and smoking as common causes.

A paper on Private Fire Departments and Fire Drills was read by Mr. R. H. Newbern, Superintendent of the Insurance Department of the Pennsylvania R. R. This paper takes up in detail the steps to be taken in forming a private fire department, the assignment of men and duties, fire drills for fire service and fire drills for schools, factories, department stores and theaters, aimed to give an effective means of clearing the buildings as well as for fire

service. The rules and instructions given cover an important part of the work of protecting life and property, and a part which is now receiving more and more attention.

The chief event of the afternoon session was an address by the Hon. Walter L. Fisher, Secretary of the Interior. An abstract appears elsewhere in this issue.

Mr. U. C. Crosby, of New York, the first President of the Association and one of its three honorary members, made a short address following Mr. Fisher's remarks. After a short address by Mr. C. H. Phinney, Vice-President, a rising vote of thanks was given to Secretary Fisher.

The Committee on State Fire Prevention Associations made a report showing marked progress in many states. The work of these state associations includes inspection work as to the causes of fires and inspection to see that rubbish and other combustibles are not allowed to collect in dangerous places. Such associations are needed in every state to give publicity to the work of fire prevention and to interest and cooperate with the state and municipal authorities in providing laws safeguarding life and property. One important object to obtain is the passage of state building codes, similar to that of Ohio. Laws are needed fixing responsibility upon the architect and the contractor. The committee and the Association stand ready to give assistance at all times to such state organizations. The report was adopted without change.

The Committee on Fire Prevention Ordinances submitted a report containing 22 printed pages. This report includes a fireworks ordinance, a motion picture machine ordinance, an ordinance covering the storage and handling of nitrocellulose films in connection with motion picture film exchanges, an ordinance to regulate the use, handling, storage and sale of petroleum and coal-tar oils and the products thereof, an ordinance covering the erection and care of automobile garages, and an ordinance covering the use of gasoline, etc., in the so-called "dry cleaning processes." The report was adopted as read.

On Thursday morning, May 25, the Committee on Signaling Systems reported. This report, in the main, follows the specifications which have already been in force with the National Board of Fire Underwriters. This was a unanimous report of the committee and was adopted without discussion. The Committee on High Pressure Fire Service Systems reported nothing new. The Committee on Theatre Construction submitted a very complete and interesting report covering in detail the necessary requirements for fireproof construction, arrangement of seats and aisles, passages, entrances and exits; the report was distributed as a pamphlet filling 19 pages. The minimum width of all entrance and exit doors is required to be 5 ft. in the clear. Detail specifications are given for the construction of fireproof curtains for the proscenium opening. The committee made special acknowledgment to the American Institute of Architects for its cooperation.

The principal event of the closing day was an address by Mr. Herbert M. Wilson, Chief Engineer of the U. S. Bureau of Mines, on "Mine Fires." This paper is abstracted on p. 672 of this issue.

The Committee on Electric Railway Light and Power Properties asked to have their work extended over another year, which was done. The Committee on Explosives and Combustibles, which is the same in personnel as that of the National Board of Fire Underwriters, had no report to make.

The Nominating Committee recommended reelection of the present officers, and its report was adopted, the officers being as follows: President, Mr. W. H. Merrill, of Chicago; Vice-President, Mr. C. H. Phinney, of Boston; Secretary-Treasurer, Mr. F. H. Wentworth, of Boston. Mr. F. J. T. Stewart was elected Chairman of the Executive Committee.

Reinforced-Concrete Work in Cold Weather.

By GEORGE C. NEWTON.*

With the rapidly increasing demand for reinforced-concrete buildings, a demand accompanied by a corresponding decrease in the time allowed for their construction, the necessity of winter construction work in this line is very commonly met. Although a great deal of concrete work has been constructed in the winter time for several years, in many cases the methods used have been very largely makeshift, with materials uncertainly heated and no certainty of result. And often the methods are quite expensive, causing the work to be very uneconomical. As a rule the methods are so uncertain that no engineer could feel absolutely safe as to work so constructed. On the construction work described in this paper, it was the attempt of the contractors to carry on winter work under methods that would assure good results and at the same time be reasonably economical. For it is unfortunately the case that most winter construction work is let at prices too low for that class of work, a condition due to its being a slack time of year, and much competition, from which the natural result follows that the work is usually poorly executed.

The Bradley Knitting Co. warehouse is a 3-story structure, 64 x 112 ft. in plan, of standard reinforced-concrete construction with brick curtain walls. Instead of the brick curtain walls being set flush with the face of exterior concrete columns, however, the outer course of brick is set out enough to veneer all concrete columns, beams and surfaces, so that all concrete work is concealed. Being located on low ground, with drainage from all directions towards its site; there is no basement in this building. The warehouse is located with the other buildings of the Bradley Knitting Co., at Delavan, Wis., a town of about 2,000 population. The building was designed by the Hirshberg-Washburn-Williams Co., of Milwaukee, and was built by the Newton Engineering Co., of Milwaukee.

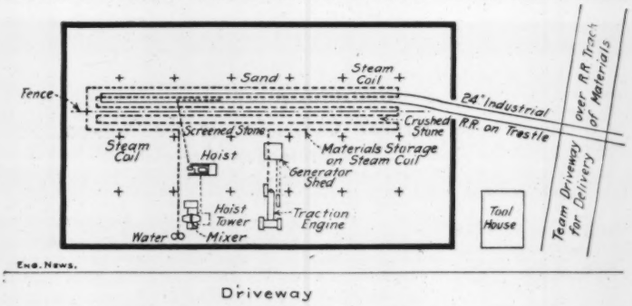


FIG. 1. GENERAL LAYOUT OF CONSTRUCTION PLANT INSIDE OF BUILDING, BRADLEY KNITTING MILLS REINFORCED-CONCRETE WAREHOUSE.

The contract was let in the early part of December, 1909, and the short time allowed for completion necessitated the construction work being carried on in the winter of 1909-1910, a winter said to have been the coldest and worst in 30 years. In fact the mean temperature for one month of this time was between 10°-15° above zero. The items of rather special interest in the construction of this work were, first, the method and plant used for handling the work in the extreme cold weather, and second, the order in which the work was handled.

Feeling certain, at the time the work was started, that some cold weather would be encountered, the contractors decided to handle the work with electric power, since electrical machinery, unlike steam or gasoline, is very nearly independent of weather conditions or extreme cold. It seems to the writer that electric power is more nearly ideal for most forms of construction work, than any other power. Its reliability alone ought in most cases to cause its use, for with no other power can the long continuous runs, so often required of construction plants, be made with any certainty of operation. Then there are the other advantages of economy both in power, cost and attendance, low cost of and very infrequent repairs and finally the amount of careless and ignorant treatment that it can stand and still operate.

As no electric power was available at I[illegible] it was necessary to generate the power for this work. For this purpose and to furnish all steam needed for heating purposes on the work a 20-HP. traction engine was installed operating a 13-HP. 550-volt motor with connections changed for use as a generator, the generator being belt driven from engine. A small switchboard was used, with voltmeter, low capacity ammeter, rheostat, cut outs and main switch. In addition to operating the generator, the traction engine furnished steam for a large steam coil which was built on the ground underneath the material piles. The exhaust from the steam coil instead of returning to the boiler, was exhausted directly into the water barrels for the concrete work through a special heating device.

The concrete plant consisted of a mixer, direct-connected to 5-HP. electric motor, discharging the concrete directly into the bucket of the concrete hoist, devised by the contractors. This hoist consists of sectional steel tower and track, hoisting bucket operating in this tower and guided on the track by steel clips which grip the track and slide on it, and head frame. One of the special features of this type of concrete hoist is the manner in which the track is bent at the bottom, so that the bucket may travel far enough under the mixer to receive the concrete direct without the use of any chute or other device. This hoist was operated by a 10-HP. single-drum electric hoist, having a special friction hoist drum added on at end of regular drum, to operate for pulling cars of material, or other work. In addition to the concrete plant proper, there was a 5-HP. electric friction hoist for handling the brick, mortar, lumber, steel and other materials, aside from concrete. And for use on form work, there was a saw table driven by a 2-HP. motor. However, it was never necessary to operate more than 17-HP. of motors at one time, and with this amount in operation their loads so balanced in that their load factor was not much over 50%, so that the 13-HP. motor used as generator with capacity of about 10 KW. was always able to furnish ample current.

The excavation for the foundations was made in zero weather and the foundation concrete was placed in weather fluctuating around zero most of the time. To handle this part of the work, the plant was set up temporarily at one end of the building and a large boiler plate with fire underneath used to heat the materials. Screened gravel or crushed stone was called for under the specifications, but no supply of either was available due to poor railroad facilities and general closing of all gravel pits due to cold weather. Bank gravel was used and screened by the contractor, various schemes being tried to accomplish this. Considerable trouble was encountered with the gravel freezing solid on its way from the pit. Although the weather was extremely cold while the foundations were being poured, by the use of salt, warm water, and warm materials, all the concrete came out in excellent shape. A very interesting thing noted on the foundation work was the way that a covering of manure and snow over the excavations for footings would keep the ground below soft and unfrozen even in weather 20° below

*Newton Engineering Co., Milwaukee, Wis.

zero, so that it was never necessary to thaw the ground before placing concrete on it.

In view of the extreme weather conditions, as soon as the foundations were completed, the construction plant was moved inside the building site and set up in permanent shape, during which time the brick walls were carried up one story and the forms built for the second floor; thus hoisting in the plant. To allow for the construction of the outside concrete columns which were to be semi-encased by the brick walls, slots were left in the brick walls at the column points, the slots being in the two inner layers of brick, the outside or facing being built entire. Forms were thus required for approximately half the size of the column, as one entire face and two half faces of the column were the sides of the slots in the brick walls. Semi-column forms were set opposite the slots and clamped by means of wires inserted through the brick walls at the time the walls were built. On the outside, these wires were connected to cleats set across a vertical plank which was placed on outside of wall at all column points (see Fig. 2). As an additional safeguard against the bursting of the face brick layer, due to pressure as the columns were poured, a ¼-in. iron rod, bent to form a stirrup, was laid in the mortar every seventh course at all column slots. Very little difficulty was experienced in handling the column construction in this somewhat unusual manner. The great advantage of following this procedure in construction work in cold weather is that it allows the brick work to be carried in advance of the concrete, thus enclosing the building within its own walls instead of necessitating housing in with canvas or lumber. And the brick walls afford much more protection from the cold than do temporary housings. In fact with brick walls on the sides, windows covered, and a floor form complete, the heat of salamanders under the forms was more than ample to keep all floor concrete from freezing. Another gain by this method lies in the fact that on rush work following the other methods, difficulty is often encountered in the removal of the supports under outside beams and girders in time to allow the brick work to proceed. A disadvantage in this method of construction, however, is the leakage of cement mortar over the surfaces of the brick walls, requiring rather laborious cleaning.

FIG. 2. VIEW OF REINFORCED-CONCRETE WAREHOUSE WITH BRICK CURTAIN WALLS.

(Note timber reinforcement to brace brick walls against concrete pressure in the columns during pouring.)

The general layout of plant and equipment is shown in Fig. 1. The material was teamed to the site at the west end, and there the teams were driven up an inclined plank driveway with level platform at the top, so that the materials could be dumped directly through traps into the car below. From under this team driveway was a 24-in. gage industrial track, leading up an inclined trestle into the building and then through the center of the building on another trestle. The car was a special material car, designed to dump its contents one side only by means of its hopper bottom and a gate on side, controlled by a cable which could be wound and unwound. When gravel was hauled in on the car, before the gate was opened, a screen was attached to side of car under the gate, the lower end of this screen resting on a fence which divided the sand from the screened gravel. Then as the gate on the car was opened, a stream of gravel would pass over the screen, the sand falling through and stone rolling over and collecting on other side of fence. Underneath the material piles had been laid a long steam coil consisting of about 500 ft. of 1½-in. pipe which was connected directly to the traction engine boiler for its supply, and exhausted into the water barrels at the concrete mixer. The traction engine was located centrally in the building, its stack being continued right on up through the floors as fast as they were put in. The concrete hoisting tower was located in the elevator shaft with mixer alongside and hoist between it and the railroad trestle, so that the hoist could operate the concrete hoist while its auxiliary drive handled the cars on the trestle and incline. The brick and other material were hoisted on the outside of the building using the 5-HP. friction hoist and a small figure four derrick.

The concrete plant was operated in the following general manner. While the forms and the brick walls for a story were being built, materials would be delivered and hauled inside on the railroad. The steam pipes were kept warm all the time so that the material might thaw out and remain so until enough was on hand to run the concrete for an entire floor. At first it had been the practice to admit steam at low pressure to the heating coil continuously, and exhausting all the time into the water barrels. But a method which seemed more economical was finally made use of. Full boiler pressure would be admitted to the steam coil all the time, the exhaust valve being closed most of the time but opened every half hour or oftener to clear out the condensed steam and keep the pipes hot. The steam coil was laid in the form of a continuous coil, as the usual method of headers and parallel pipes would be very uncertain as to circulation through all the pipes, under such conditions, especially with the exhaust being into a barrel several feet above the steam coil. In building such a coil for similar work again, a probable improvement would be to perforate the pipe every 2 or 3 ft. with very fine openings, so as to allow live steam to escape directly into the material in very small jets.

The concrete for each floor was placed in practically a continuous run, there being about 160 cu. yds. of concrete to each floor. This method eliminated all necessity for stops at ends of day's work (always a source of trouble on reinforced floor work with considerable numbers of bars used for reinforcement), and was especially advisable on work in cold weather where the work must be protected and kept warm. Remarkable runs were made on the concrete. The concrete (160 cu. yds.) for one floor (about 900 batches) was mixed in 18 hours, and when laying the roof 540 batches were mixed in ten hours. As fast as the floors were concreted the fresh concrete was covered with canvas, so that the concrete, as protected by this covering, use of salamanders below the forms, salt in the water for concrete and warm material and water, came out in perfect shape and no trouble with frozen concrete was encountered.

The floors were run rough without a finish coat and after all were completed, a finish surface ¼-in. thick of 1:1½ mortar was applied, using Livingstone bond to unite the finish coat to the concrete. This method allows the finish to be put on under better conditions of protection from weather, etc., and eliminates much of the checking and cracking usually encountered in concrete construction where the finish is put on along with the regular concrete work.

As soon as the brick walls and concrete floors and roof were complete, the finish surfaces on floors were put on, roofing laid, and interior work such as tile partitions, woodwork and iron doors built and placed. Then the entire interior of building was white painted, using a cold water paint and spraying machine. As fast as a floor was complete, the owners started to use it.

The total time taken for this building was about three and one-half months, of which time at least 50 days had temperature below 15° all day, and many days were way below zero. The construction of this building under extreme weather conditions and obtaining results which compare favorably with regular warm weather work, would seem to show as has been shown by much construction work throughout the country, that winter construction work in reinforced concrete is entirely practical as far as results go. Whether winter construction work is desirable from the standpoint of cost is another matter. Under present conditions, it would seem in most cases not to be. Probably the worst item facing the contractor is the general lack of knowledge on the part of architects and contractors as to cost of winter work, the idea apparently being that all the expenses of heat, protection, etc., cost little, and that winter work is cheaper than summer because of some imagined saving in labor, and the holding of the contractor's organization intact. Instead of this latter being the case, it has been the writer's experience on different pieces of winter work that labor in cold weather is very expensive, costing in general 30 to 50% more, especially in the skilled lines, and that for a contractor to hold his organization on hard, steady winter work is almost certain to demoralize them for the next year, besides losing him many good men. Until these conditions are realized and the prices made sufficiently high to offset them, winter construction work is not likely to tempt the better grade of contractors.

WORK ON THE LAHONTON DAM, which will form a part of the Truckee-Carson Project, U. S. Reclamation Service, will be started as soon as the necessary machinery is installed. A railway track has already been laid between the dam site and Lahonton Station, on the Southern Pacific, and the labor construction camp is ready. The following description of the dam has been issued by the U. S. Reclamation Service:

The Lahonton Dam will be located on the Carson River, just below the outlet of the main Truckee Canal. It will consist of an earth embankment having a length of 1,350 ft., a maximum height of 125 ft., and a volume of about 750,000 cu. yds. It will form a storage reservoir having an area of 11,000 acres, and a capacity of 290,000 acre-feet. The embankment is to be 20 ft. wide on top with an up-stream slope of 3 to 1 protected by 2 ft. of riprap, and a down-stream slope of 2 to 1, protected by 1 ft. of riprap. Near the up-stream toe of the dam there is a cut-off trench 15 ft. in depth, having a concrete wall 2 to 4 ft. in thickness extending to an additional depth of 30 ft. The concrete spillways are to be constructed, one at each end of the embankment, having the crest 12 ft. below the top of the dam. The length of each spillway is 250 ft., and the water will flow over concrete steps to a circular pool in the river bed near the toe of the dam. This pool will have a diameter of 330 ft. and a depth of 30 ft., and will serve to retard the velocity of the water sufficiently to allow its discharge into the old river bed without danger of eroding the soil.

The outlet work consists of twin concrete conduits of horseshoe shape, approximately 8 ft. in diameter. The gates are to be operated from a gate tower at the upper end of the conduit. The estimated cost of the dam is $1,250,000 and the estimated quantities are as follows:

Excavation	268,000 cu. yds.
Embankment and backfilling	713,400 cu. yds.
Concrete	60,375 cu. yds.
Paving and riprap	26,900 cu. yds.
Steel	600,000 lbs.

Honors to a Long Dead Engineer, Pierre Charles L'Enfant.

It is so infrequently that an engineer receives the tardy tributes with which posterity sometimes repays genius that we are moved to reprint here several extracts from the speeches made at the recent unveiling of the monument to Maj. Pierre Charles L'Enfant, the French Engineer Officer who, 120 years ago, designed and initiated the city plan of the city of Washington. Two years ago the remains of L'Enfant were brought from their 84-year resting place on an obscure Maryland farm and interred with appropriate ceremony in a grave in the National Cemetery at Arlington, Va., overlooking the city that he had foreseen. Over this grave there has just been completed the memorial authorized by the federal Congress, a horizontally placed tablet of marble, mounted on ornamental columns, and bearing on its upper face a carved replica of that original map which has so faithfully been followed in the street and park plans of the Capital City.

At the unveiling of the monument, on May 22, the principal addresses were delivered by President Taft, the Ambassador from France, M. Jusserand, and Senator Elihu Root. The President said, in part:

We are here to celebrate the last rites of the man who designed the plan, the execution of which has made Washington beautiful. There are not many who have to wait 100 years to receive the reward to which they are entitled until the world shall make the progress which enables it to pay the just reward.

Coming as a soldier from France, he entered the Engineer Corps of the army, and rendered distinguished service in the Revolutionary War. His skill as an engineer and his art as a designer led Washington to select him as one to make the plan for the Capital city.

Jefferson, the Secretary of State, interested with Washington in making that plan as successful as possible, assisted the artist with his suggestions, and sent him the plans of many European cities. Jefferson was himself an architect of high skill. Washington was a surveyor, and knew the ground. Both were patriots and statesmen, with lofty ideas of the nation's capital.

There is not any doubt that the suggestions which both these great men gave to L'Enfant assisted him much in the work which he had to do. Nevertheless, the working out of the suggestions, the compliance with the purposes of those men whose directions he was following, required the genius that he exhibited and gave us the plan we have.

I would not for a moment detract from Capt. Elliott's merit. Himself a surveyor, he modified or followed the suggestions of modification that Washington desired in the plan after L'Enfant had drafted and completed them. But the evidence goes to show that the great originality in the plan was L'Enfant's; that where the ideas in the design were original they were L'Enfant's.

It is those original ideas that the board of artists who have designed the future development of Washington have taken, and do not claim even to have improved upon.

All Americans who take pride in the capital and its development, therefore, must feel deep gratitude to L'Enfant for what he did, and must rejoice that now, eighty-six years after his death, the time has come when we are paying him just tribute in sight of the city that he designed, in a place full of tender memories for the nation, a beautiful estate dedicated to the patriotic dead, furnishing a terminal—and a proper terminal—for the design of the future for the city of Washington.

L'Enfant will now lie here appropriately in state and rest, with the gratitude of the nation that he served so well.

Ambassador Jusserand, following the President, delivered a characteristically learned and graceful address from which we find space only for a few short sentences.

All of those who visit the federal city are unanimous in their praise of its beauty and its exact adaptation to the needs of a great nation. With the mind of a poet, with the soul of a prophet, perceiving future ages as clearly as if they were the present, a man foresaw, over a century ago, what we now see, and that man lies under the monument which a generous vote of Congress allows us to dedicate to-day—Maj. Pierre Charles L'Enfant.

The city he planned was meant, not for men of his day, but for those of ours, and when the time shall come that people will wonder at our own wonder at the rapid expansion of this country, when the hundred million inhabitants of to-day will look like a petty number, still L'Enfant's plan will hold good, and for our successors as for us, he might be able to say, "For you it was that I worked."

On this hill, from which is discovered one of the finest sights in the world, the city of beautiful buildings and shady avenues that he knew would rise one day, a great city for a great nation, L'Enfant now rests among his peers. He fought for American independence; he believed in the future of the country; well may he rest in the midst of that army of the dead who in their lifetime, at the sad hour of another great struggle, saved the Union.

A New Design of Railway Coaling Station.

A compact coaling station which occupies little space, has considerable storage capacity, and provides for coaling two locomotives simultaneously, has been erected at Waukegan, Ill., for the Elgin, Joliet & Eastern Ry. This is shown in Fig. 1, while Fig. 2 is a sectional elevation of a similar plant of larger capacity.

The coal is delivered in hopper-bottom railway dump cars and discharged into a concrete receiving hopper beneath the track. This hopper has a lateral discharge to the boot of an elevator or hoist having a Holmen dumping bucket of 1½ tons capacity. The outlet from the track hopper is fitted with a rotary charging gate or feeder which is operated automatically; the gate holds a full charge for the bucket and when the bucket is in place at the bottom of the loading pit, the gate revolves so that its open side is over the bucket while its other side closes the hopper outlet. As the bucket rises, the gate revolves so that its open side is opposite the outlet, allowing another charge to flow into the gate. The bucket works in a steel tower 85 ft. high, and operated by an electric hoist in a cabin at one side of the tower. On reaching the top of its travel the bucket is dumped into the conical head of a cylindrical steel bin or pocket having a capacity for 100 tons of coal. This tank is directly over one of the coaling tracks, and is supported at one side by a steel bent between these tracks and at the other side by the hoisting tower. The hoisting capacity of the arrangement described is 40 tons per hour (or 60 tons for the plant in Fig. 2). Similar plants may be built with concrete pockets.

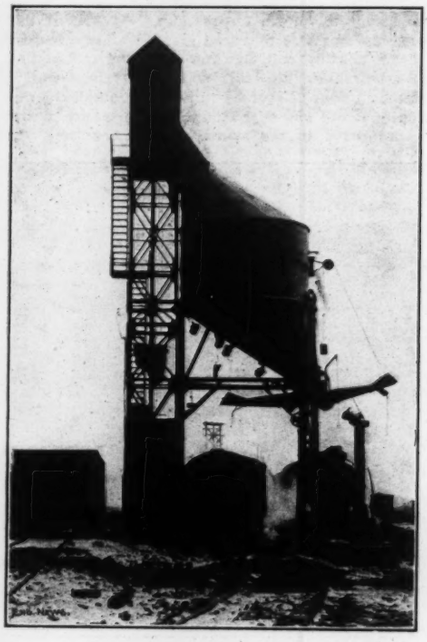


Fig. 1. An Electrically Operated Coaling Station at Waukegan, Ill.; Elgin, Joliet & Eastern Ry.

The bottom of the pocket is conical, but eccentric to the pocket proper, being so arranged that the apex comes between the two coaling tracks. Two pivoted and counterweighted aprons or chutes, each with an undercut gate to regulate the flow, project on opposite sides of the apex. This is shown in Fig. 2, with both chutes lowered and delivering coal. In Fig. 1 both chutes are raised. The engine on the right is coming up to take coal, while the one on the left has taken a supply and is pulling away from the coaling station. In the tower may be noted one of the dump buckets, while to the left of the tower is a car on the receiving or hopper track. The water column is supplied from a tank to the left of this track.

This coaling station was designed and built by the Roberts & Schaefer Co., consulting engineers and contractors, Old Colony Building, Chicago.

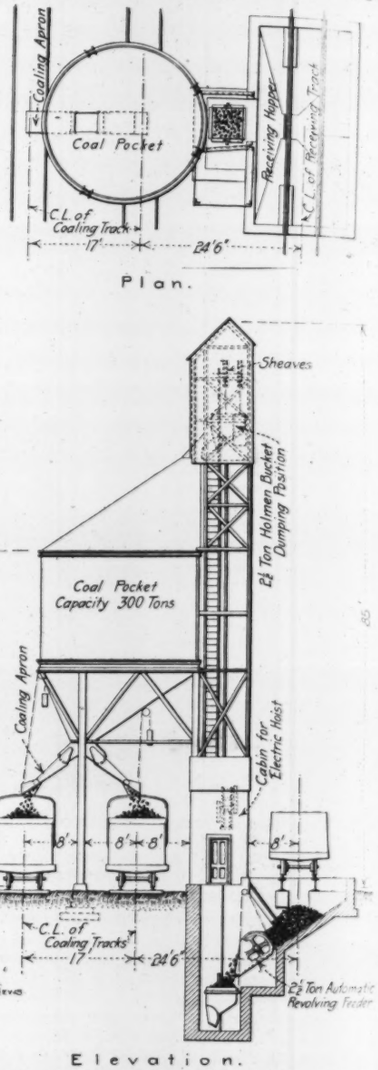


Fig. 2. Sectional Elevation of Electrically Operated Coaling Station.
(Roberts & Schaefer Co., Chicago; Builders.)

and it includes several patented features. It is one of a number of improvements made recently at the Waukegan engine terminal of the Elgin, Joliet & Eastern Ry., under the direction of Mr. A. Montzheimer, Chief Engineer. These include the coaling station, a 15-stall roundhouse of reinforced concrete, a concrete oil house, an ash-pit (with depressed track for ash cars), and an 80-ft. turntable with electric tractor.

Notes from Engineering Schools.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY.—The Institute has recently established a summer camp for engineering instruction. It is intended to replace a large portion of the present surveying work and general out-door

practice, which is given under a great handicap, by courses at the summer camp. Six or eight weeks in camp following the second year will probably be the rule. The courses will be obligatory and will include civil, mining, sanitary, railway and hydraulic subjects. Only enough field work will be given hereafter near Boston to make students familiar with the principles of the instruments and their handling. When the Institute was established, the whole Back Bay was available for exercises, but now it is necessary to go by train to Hyde Park or some neighboring place. This leads to endless delays and "lost motion" so that the prescribed four hours period yields only two of practice.

The Institute has secured Crosby's Point, Gardner Lake, near Machias, Maine. This point has an area of 1½ square miles and nearly divides the lake. The shore is irregular and with the rough country in the vicinity gives opportunity for varied work. Three rivers of different size are within a few miles, for stream study. Nearness to the ocean admits of basing measurements on tide water. Permanent administration buildings and temporary camp structures will be erected this year; next season the whole camp will be made permanent.

PRATT INSTITUTE.—A special feature of the annual exhibition of the students of Pratt Institute, Brooklyn, N. Y., will be the opening of the new tannery, provided for the courses in leather and tanning chemistry which are to be conducted in cooperation with the National Association of Tanners.

This exhibition is intended to afford an opportunity for all interested to inspect the results of student work, the methods of teaching and the general facilities for training in industrial and technical lines.

A BUTTING COLLISION occurred May 29 between two passenger trains on the Chicago, Burlington & Quincy R. R. three miles west of McCook, Neb. Both locomotives and the three forward cars of each train were demolished. Fourteen persons were killed and about 20 others injured.

A FIRE AT CONEY ISLAND, New York City's seaside amusement resort, May 27, destroyed the park or collection of shows known as Dreamland. The fire started not long after midnight and attained considerable headway before being discovered. The park employees delayed turning in an alarm for five or ten minutes, thinking they could extinguish the fire unaided. A number of trained wild animals were killed. The total loss is estimated at several million dollars, only a small fraction of which is covered by insurance owing to the almost prohibitive rates applying to such structures.

Trouble was experienced at the Coney Island high-pressure pumping station due to the large number of hose lines (30 to 40) connected to the high-pressure hydrants. Fire companies were called from all parts of Brooklyn—most of them unfamiliar with the Coney Island system—and poor judgment was used, according to Chief Engineer I. M. de Varona of the Department of Water Supply, in the use of the high-pressure supply. As a result the gas-engine pumping units were much overloaded so that the pressure fell at times to 20 or 30 lbs. The engines raced on account of the low pressure and became overheated.

ELECTRIFICATION OF THE RAILWAYS ENTERING Boston is likely to be favored by the Massachusetts Legislature. The Committee on Railroads and Metropolitan Affairs on May 25 voted 14 to 12 for a measure which provides that all the standard-gage railways within the Metropolitan district shall be electrified in such manner and such order as the Board of Railroad Commissioners may determine. The railways are to file plans and specifications for electrification with the Railroad Commission before Sept. 1, 1912. The Commission shall determine the extent to which public necessity demands electrification and shall fix a date for beginning the work.

THE SEWICKLEY CANTILEVER BRIDGE WAS joined on May 16, without difficulty or incident. This highway bridge has a channel span of 750 ft. (containing a suspended span of 350 ft.), shore arms of 300 ft. each, and viaduct approaches totaling 503 ft., making a length of bridge of 1,853 ft. over all. It has two trusses 32 ft. apart, with a roadway carrying double-track electric railway line between trusses, and footwalks overhung outside the trusses. It crosses the Ohio River at Sewickley, Pa., and is being built by Allegheny County. The Fort Pitt Bridge Works, of Pittsburg, Pa., are the contractors.

THE STANDARD TESTING LABORATORY, proposed for the City of New York and described in Engineering News, April 27, p. 521, was approved by the Board of Aldermen on May 23. The Committees on Establishment of Salaries and Grades, and on Allotment of Space in the New Municipal Building were instructed to provide for employees and quarters. An appropriation of $15,000 was made to provide equipment and salaries to permit immediate work in a temporary laboratory.

A REPORT ON THE TYPHOID EPIDEMIC AT Ottawa, Ont., has been made by Dr. C. A. Hodgetts, Sanitary Expert of the Ontario Conservation Commission. In a general way, his conclusions are similar to those submitted by Dr. P. H. Bryce in an article on the outbreak contributed to Engineering News, March 23, 1911. The contamination of the water-supply, owing to unusual local conditions, is held responsible. These conditions included unusually low water in the Ottawa River, from which the supply was taken, accompanied by the freezing of the water to the bottom, in places "blocking some of the ordinary channels," followed by a freshet in the first week in January; the occurrence of a typhoid outbreak in Mechanicsville, not far above the intake last fall; the opening of the emergency valve at a point in the water-works intake near the shore line; and the possible contamination of the water-supply main by sewage which from September, 1910, to the middle of January, 1911, was admitted to the old raceway in which the pipe is laid. A detailed inspection of Cave Creek, which discharges into the river not very far above the intake, showed a considerable amount of direct and indirect pollution from privies in an unsewered section of the city; there are indications of pollution along the Ottawa River, also. The records show that there were 56 cases of typhoid fever in Ottawa in 1909 and 80 in 1910, and that the total deaths from typhoid fever for the ten years ending 1910 numbered 200; many of the latter, however, were hospital patients who had come from the outside of the city. The recent outbreak extended over ten weeks. There were 31 cases in the first week, 70 in the second and 136 in the third. In the next four weeks the number of cases ranged from 111 to 119 per week. In the eighth week they fell to 94 and in the ninth to 79. In the tenth week there was a heavy drop to 25 and in the eleventh week only four cases were reported. It is stated that the epidemic would probably have been checked earlier had the hypochlorite treatment been conducted in a more efficient manner from the outset, and that probably the outbreak would have been prevented entirely had the hypochlorite plant been installed immediately after the recommendation to that effect as made by Mr. Allen Hazen, M. Am. Soc. C. E., of New York City, on Oct. 5, 1910. From an abstract of the report, published in the Ottawa "Evening Journal" of April 17, it appears that while the main investigation and report were made by Dr. Hodgetts, there were associated with him Dr. R. W. Bell, Col. Jones and Major Drum, each of whom signed the report.

THE MUNICIPAL COLLECTION AND DISPOSAL of ashes, rubbish and stable manure has been recommended in a report by Mr. Irwin S. Osborn, Engineer-in-Charge of Garbage and Refuse Disposal, Columbus, Ohio. The report was made at the request of Mr. Henry Maetzel, Chief Engineer of the Department of Public Service, Columbus, Ohio. Mr. Osborn believes that ashes could be collected by the city for much less than the cost of their collection by private scavengers, that rubbish could be collected for "about one-third what it is now costing the householders, and all rubbish would be collected"; and that the revenue to be derived from manure collected by the city would at least pay for the service. He is of the opinion that the collection and disposal of rubbish by the city would be beneficial from a health standpoint and that municipal service in all three lines would relieve the Street Cleaning Department of "the unnecessary burden imposed upon it" by the scattering of various classes of refuse in the streets and alleys of the city. The municipal collection of rubbish would be advantageous to the city garbage reduction works, since a considerable amount of rubbish is now mixed with the garbage. The exclusion of this rubbish from the garbage would increase the revenue from the by-products of the reduction works. The thorough collection of manure, Mr. Osborne states, would eliminate breeding places for flies and thus cut down the number of disease-conveying agents in the city. The estimated cost of the necessary equipment for separate collection of ashes, rubbish and manure is about $27,000. This would provide for 20 wagons for ashes, 12 for rubbish and 10 for manure, at a cost of $250 each; double the number of horses for each service at $200 each, and double the number of sets of harness at $30 each. The estimated cost of an incinerating plant for the rubbish is $38,000 without and $52,500 with a plant for utilizing the salable materials sorted out from the rubbish. Collection costs are estimated at $27,900 per year for ashes; $14,880 for rubbish, and $63,380 for manure, making a total of $106,160. The cost of rubbish disposal is placed at $5,038 per year without utilization, or $16,120 per year for a utilization plant with an incinerator; in the latter case, however, there would be an estimated revenue from papers, rags, bottles, etc., of $9,570 and a further revenue of $714 from utilization of steam, making a total revenue of $10,284, and leaving the net cost of rubbish disposal by a utilization plant $5,836. The interest and sinking fund allowances, at 4% each, are figured in the estimates for operating the incinerator and utilization plant, but no such allowances appear to have been made in connection with the estimates for the cost of collecting the various classes of refuse.

A BADLY OVERLOADED POWER PLANT is disclosed by the recent campaign of the University of Michigan for an appropriation to build a new central station. The boilers in the present plant have a rated capacity of 325 HP. and are used for heating and lighting the University buildings. The electric generators have a rated capacity of 350 KW. and a connected load of 1,537 KW., if the equipment were all in service at once. In order to hold up the service under these loads various expedients have been adopted to economize power. All buildings have been equipped with heat regulators and weather-strips; metal-filament lamps have been substituted for the less efficient carbon type; the steaming performance of the boilers has been increased by erecting additional sheet-iron stacks and using Pocahontas coal; every possible lamp or motor is put out of use during hours of peak load. The University has secured an appropriation of $280,000 for a new heating and power plant.

Personals.

Mr. C. H. Jones has been appointed Chief Engineer of the New York & Pennsylvania R. R. with headquarters at Canisteo, N. Y.

Mr. James H. Fuertes, M. Am. Soc. C. E., left New York on May 31 for Para, Brazil, where he has been engaged to investigate the sewerage system. He expects to return to New York about July 15.

Dr. Patrick H. Mullowney has been appointed Commissioner of the Health Department of Boston, Mass. Dr. Mullowney is a physician and has been in charge of the Bureau of Dairy Inspection. His salary will be $4,000 per annum.

Mr. A. Trauers-Ewell, recently Assistant Locating Engineer for the Bangor & Aroostook R. R., of Maine, has been appointed Topographical Engineer in charge of all surveys for the Aproma Goldfields, Ltd., at Tirapata, Peru. Mr. Ewell left New York on May 13.

Mr. C. S. Williamson, Assoc. M. Am. Soc. C. E., has resigned as Contracting Engineer for Heyl & Patterson, Inc., of Pittsburg, Pa., to accept the position of Manager of the Western Department of the Mead-Morrison Mfg. Co., with offices in the Monadnock Bldg., Chicago, Ill.

Mr. L. G. Berry, Assoc. M. Am. Soc. C. E., has resigned as Contracting Engineer with the Des Moines Bridge & Iron Co., and has organized and will manage the Southern Engineering Co., Engineers and Contractors for structural work in steel and concrete, with headquarters at Charlotte, N. C.

Mr. H. I. Miller, formerly President of the Chicago & Eastern Illinois R. R., the Evansville & Terre Haute R. R. and the Evansville & Indiana R. R., has been elected a Vice-President of the Missouri Pacific Ry. Mr. Miller was for several years in the engineering department of the Pennsylvania R. R., and has recently completed an expert examination of the Missouri Pacific lines.

Mr. Josiah Pennington, an architect of Baltimore, Md., has been appointed President of the City Planning Commission of that city, succeeding Mr. F. K. Carey, whose resignation was announced last week. Mr. Pennington has been a member of the commission for some time past and has been chairman of the special committee on plans.

Mr. E. O. Sessions, M. Am. Inst. E. E., for 23 years with the General Electric Co., in its engineering and sales departments, has become a member of the firm of Woodmansee, Davidson & Sessions, Inc., Consulting Engineers, with offices in the First National Bank Bldg., Chicago, Ill. An announcement of Mr. Davidson's association with the firm was made in these columns on May 4.

Dr. Karl Imhoff, of Essen, Germany, Chief Engineer of the Emscher Valley Drainage Board, described in Engineering News of Dec. 1, 1910, is visiting the United States. Dr. Imhoff was the guest of honor at a dinner given at the Engineers' Club in New York City on the evening of May 25, which was attended by a number of the principal engineers of New York interested in water supply and sanitation.

Mr. C. S. Cunningham, Superintendent of the Southern Division of the Grand Trunk Ry. at St. Thomas, Ont., has been transferred to the Western Division at Detroit, Mich., as Acting Superintendent, pending the return of Mr. F. W. Egan, who has been granted leave of absence on account of ill health. Mr. C. G. Bowker, Assistant

Superintendent at London, Ont., will have charge of the Southern Division with headquarters at St. Thomas.

Dr. Guy Potter Benton, President of Miami University at Oxford, Ohio, has been elected President of Vermont University at Burlington, Vt. Dr. Benton holds the degrees of Bachelor of Arts, Master of Arts, Doctor of Divinity and Doctor of Laws. He has been Superintendent of Schools of Fort Scott, Kan., Assistant State Superintendent of Public Instruction and Secretary of the State Board of Education of Kansas, President of the Upper Iowa University and, since 1902, President of Miami University.

Mr. J. N. Shannahan, M. Am. Soc. C. E., Vice-President and General Manager of the Washington, Baltimore & Annapolis Electric Ry., has resigned, to take effect July 1. After that date he will be Railway Manager of the operating department of J. G. White & Co., of New York. Mr. Shannahan is a graduate of Rennsselaer Polytechnic Institute, class of 1894, and was for a time in the signal department of the New York Central & Hudson River R. R. In 1899 he became Chief Engineer, and in 1901 General Superintendent, of the Fonda, Johnstown & Gloversville R. R. At the same time he also held the positions of General Manager of the Edison Electric Light & Power Co., of Amsterdam, N. Y., and of President of the Adirondack Lakes Traction Co. He left these positions in 1907 to become Vice-President and General Manager of the Washington, Baltimore & Annapolis Electric Ry., at Baltimore, Md.

Mr. E. J. Pearson, M. Am. Soc. C. E., formerly Chief Engineer of the Chicago, Milwaukee & Puget Sound Ry., has been elected Vice-President of the Missouri Pacific Ry., in charge of operation. Mr. Pearson is a graduate of Cornell University in civil engineering. His first railway experience was with the Missouri Pacific as rodman, in 1880. He was connected later with the engineering departments of the Missouri, Kansas & Texas Ry. and the Atlantic & Pacific R. R. In 1883 he went to the Northern Pacific Ry. as Assistant Engineer and held many positions in the engineering and operating departments. He was for three years Superintendent of the Rocky Mountain Division and four years Superintendent of the Pacific Division. He also held the positions of General Superintendent and Chief Engineer. For the past few years he has been Chief Engineer in charge of construction of the Pacific extension of the Chicago, Milwaukee & St. Paul Ry.

Obituary.

Edward H. Johnson, an inventor of railway appliances, died at his home in Philadelphia, Pa., on May 29. He was 79 years old.

Dr. Robert W. Ells, Dominion Geologist of Canada, died from paralysis at his home in Ottawa, Ont., on May 21. He was 66 years old and had been in the Canadian Geological Survey since 1872. He was a Fellow of the American Geographical Society.

Alfred C. Lewerenz, M. Am. Soc. C. E., until recently Civil Engineer, U. S. N., stationed at the Naval Station at Honolulu, Hawaii, died in Detroit, Mich., on May 27. He was 41 years old. He entered the naval service in 1899 and was recently retired because of disability incurred in the line of duty. He held the rank of Lieutenant-Commander.

Nathaniel Wright Lord, M. Am. Inst. M. E., Professor of Mineralogy and Meteorology at Ohio State University, was found dead in his home in Columbus, Ohio, on May 23. His death is said to have been caused by organic heart trouble. Prof. Lord was born in Cincinnati, Ohio, on Dec. 26, 1854. He graduated in mining engineering at Columbia University in 1876. In 1877 he was an engineer and metallurgist for the Monde Grande Mining Co., Nicaragua. The next year he became an assistant in the School of Mines at Ohio State University. In 1879, he was appointed Assistant Professor, and in 1880, Professor. Prof. Lord was also Chemist for the Ohio Geological Survey from 1880 to 1888; for the State Board of Agriculture from 1881 to 1899, and for the State Board of Health from 1896 to 1898. He was also connected as Chemist with the U. S. Geological Survey from 1904 to 1909. He was a delegate at the International Congress of Applied Chemistry at London in 1909, and was a member of the American Chemical Society.

Charles Perry Buchanan, Assistant Engineer of Bridges of the Pennsylvania Lines West of Pittsburg, died at the Pittsburg (Pa.) hospital on April 14, following an operation for appendicitis. He was born in Newport, Ky., in 1858 and was educated as a civil engineer. In 1880 he went to Pittsburg as a bridge inspector for the Pennsylvania R. R. From this position he rose steadily to the one which he held at the time of his death. He was married in 1884 to Annie M. Courtney, who with one daughter, Mrs. Carl Allen Stutsman, of Los Angeles, Cal., survives him.

Mr. Buchanan had for years been interested in the subject of column strength, and took an active part in carrying on a long-continued series of tests of full-size chords and posts of bridges for the Pittsburg, Cincinnati, Chicago & St. Louis Ry. of the Pennsylvania Lines West. A summarized account of these tests, written by him and published in Engineering News of Dec. 26, 1907, presented the most important set of column-test results up to that time; and coming to notice immediately after the Quebec Bridge collapse of Aug. 29, 1907, it played a great part in the renewal of interest in column testing and the subject of column strength. Mr. Buchanan also conducted the tests of five bridge columns of 90 sq. ins. section, the largest ever tested, reported by Mr. J. E. Howard before the American Society of Civil Engineers a few weeks ago (see Eng. News, March 16, 1911). He was a skilful and conscientious tester, and had broad interest in the field of testing. A short article by him on tests of old timber was published in Engineering News of Dec. 8, 1910, and other communications on various testing subjects are to be found in earlier issues.

Engineering Societies.

COMING MEETINGS.

AMERICAN INSTITUTE OF MINING ENGINEERS.
June 6-10. Annual convention at Glen Summit Springs Hotel, Luzerne Co., Pa. Secy., Joseph Struthers, 29 West 39th St., New York City.

AMERICAN WATER WORKS ASSOCIATION.
June 6-10. Annual convention at Rochester, N. Y. Secy., J. M. Diven, 14 George St., Charleston, S. C.

ENGINEERS' SOCIETY OF PENNSYLVANIA.
June 7-10. Annual meeting at State College, Pa. Secy., E. R. Dasher, P. O. Box 704, Harrisburg, Pa.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
June 19-23. Annual convention at Boston, Mass. Secy., Joseph Jacobs, 803 Central Bldg., Seattle, Wash.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 13-16. Annual convention at Chattanooga, Tenn. Secy., Charles W. Hunt, 220 West 57th St., New York City.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 14-16. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

MASTER CAR BUILDERS' ASSOCIATION.
June 19-21. Annual convention at Atlantic City, N. J. Secy., Jos. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS.
June 19-23. Annual convention at Boston, Mass. Secy., P. W. Drew, M., St. P. & S. S. M. Ry., Chicago, Ill.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.
June 21-24. Semi-annual meeting at Chicago, Ill. Secy., J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 26-30. Annual convention at Chicago, Ill. Secy., Ralph W. Pope, 33 West 39th St., New York City.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 27-29. Annual meeting at Pittsburg, Pa. Secy., H. H. Norris, Cornell University, Ithaca, N. Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 27-July 1. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN CHEMICAL SOCIETY.
June 28-July 1. Annual convention at Indianapolis, Ind. Secy., Charles L. Parsons, Durham, N. C.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 25-28. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

RAILWAY SIGNAL ASSOCIATION.—The place for the stated meeting, June 13-14, in New York City has been changed to the Hotel Astor. The program will be as follows: June 13—Reports of committees Nos. I. to VI. and a paper on "Substitutes for Wood Trunking for Railway Signal Circuits," by W. K. Sparrow. June 14.—Reports of committees Nos. VII. to XII. and a paper on "Apparatus for Charging Storage Battery," by W. K. Ferguson, R. E. Russell and E. E. Kimball.

COLORADO ASSOCIATION OF MEMBERS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting of May 27 in Denver, an informal dinner was served, after which the President, Mr. Geo. G. Anderson, gave an illustrated lecture on the Panama Canal.

ALBANY SOCIETY OF CIVIL ENGINEERS.—An illustrated lecture on the Panama Canal was given at the regular meeting of May 31 by Mr. Wm. B. Landreth, M. Am. Soc. C. E.

AMERICAN SOCIETY OF ENGINEER DRAFTSMEN.—At the meeting of May 17 in New York City, the report was considered of the committee appointed to investigate the bills for licensing engineers which are now before the New York State Assembly. The committee report favored the McGrath Bill. A number of letters on the subject of licensing engineers were read. These were from non-resident members of the society and were about equally divided for and against licensing.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.—The fifth annual meeting will be held Nov. 2-4 at Cincinnati, Ohio. Mr. Fred A. Geier, President of the National Machine Tool Builders' Association, and of the Cincinnati Milling Machine Co., is chairman of the committee in charge of local arrangements. One complete session will be devoted to consideration of the industrial training given by the schools of Cincinnati, including the University of Cincinnati, the Cincinnati High School and Continuation School and the Ohio Mechanics Institute.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.—At the third annual meeting, May 18, in Chattanooga, Tenn., officers were elected as follows: President, T. Duff Smith, Winnipeg, Man.; Vice-Presidents, David Meadows, St. Thomas, Ont., and R. R. Hibben, Pearson, Kan.; Secretary-Treasurer, D. B. Sebastian, La Salle St. Station, Chicago, Ill.; members of executive committee (for two years), R. Collett, Springfield, Mo.; R. Emerson, New York City; and W. C. Hayes, New York City—(for one year) E. McAuliffe, Chicago, Ill.; J. McMurray, Grand Rapids, Mich.; and N. M. Rice, Topeka, Kan.

AMERICAN ASSOCIATION OF REFRIGERATION.—The second annual convention in Chicago, May 9-11, was attended by about 150 delegates. At the opening session 239 new members were elected. Committee reports were received on the following subjects: Gases and Units; Testing Refrigerating Machinery and Insulating Materials; Application of Refrigeration to Food, Industrial Refrigeration, Railway and Steamship Refrigeration; and Legislation and Administration. Chicago was selected as the place for the Third International Congress of Refrigeration, which will be held in 1913. Officers were elected as follows: President, William J. Rushton, Birmingham, Ala.; Treasurer, John S. Field, Chicago, Ill., and Secretary, J. F. Nickerson, Chicago, Ill.

A set of resolutions was adopted concerning the proposed national legislation relative to cold storage of perishable food products. These resolutions stated that the regulation proposed in these bills would be destructive to the interests of producers, distributors and cold storage warehouse men. They favored inspection of all foods before admission to storage and likewise their condemnation when found unfit. Publicity as to the total quantity of perishable foods in both public and private cold storage warehouses was also favored. It was considered, however, that the time limit during which goods may be kept in cold storage is unnecessary, in view of the protection to the consumer afforded by the proposed inspection. If, however, a limit be required, it should not be less than twelve months. Finally, the resolutions favored the creation of a national commission to investigate the production, packing, shipment, storage and sale of perishable foods with regard to the public health and the effect upon market prices. Said commission to recommend such legislation as was warranted by the facts developed as a result of its investigation.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—The advance program for the annual convention to be held in Chicago, Ill., June 26-30, has been given out as follows:

June 27—President's Address, by Dugald C. Jackson; Address by President-Elect, Gano Dunn; "Development of the Modern Central Station," C. P. Steinmetz; "Tests of Oil Circuit Breakers," E. B. Merriam; "The Use of Reactance Coils in Large Central Station Systems," R. F. Schuchardt and E. O. Schweitzer; "Depreciation as Related to Electrical Properties," Henry Floy, and "Important Features Entering Into Making of Appraisals," H. M. Byllesby.

June 28—"Some Data from the Operation of the Electrified Portion of the West Jersey & Seashore Railroad," B. F. Wood; "Analysis of Electrification," W. S. Murray; "Solution to Problems in Sags and Spans," W. L. R. Robertson; "Induction Machines for Heavy Single-Phase Motor Service," E. F. W. Alexanderson; "Automatic Motor Control for Direct-Current Motors," Arthur C. Eastwood; "Some Limitations of Rheostat Control," T. E. Barnum; "Control of High Speed Electric Elevators," L. L. Tatum; "Electrically Driven Reversing Rolling Mills," Wilfred Sykes; "Electric Vehicles," P. D. Wagoner; "Multiplex Telephony and Telegraphy by Means of Electric Waves Guided by Wires," George O. Squier; "Telegraph Transmission," F. F. Fowle and "Commercial Loading of Telephone Circuits in the Bell System," B. Gherardi.

June 29—"The Law of Corona and the Dielectric Strength of Air," F. W. Peek, Jr.; "Mechanical and Electrical Characteristics of Transmission Lines," Harold Pender and H. F. Thomson; "Dielectric Strength of Air," J. B. Whitehead; "Sag Calculations for Suspended Wires," P. H. Thomas; "Transmission System of the Great Western Power Co.," J. P. Jollyman; "Transmission System of Southern Power Co.," W. S. Lee; "Transmission System of the Great Falls Power Co.," M. Hibgen; "The High Efficiency Suspension Insulator," A. O. Austin, and "Electric Line Oscillations," G. Faccioli.

June 30—"Economical Design of Direct-Current Electro-Magnets," R. Wikander; "Electrolytic Corrosion in Reinforced Concrete," C. E. Magnusson and G. H. Smith; "Wave Shape of Currents in an Individual Rotor Conductor," H. Weichsel; "The Choice of Rotor Diameter and Performance of Polyphase Induction Motors," Theodore Hoock; "The Application of Current Transformers in Three-Phase Circuits," J. R. Craighead; "The Cost of Transformer Losses," R. W. Atkinson and E. C. Stone; "Tentative Scheme of Organization and Administration of a State University," Ralph D. Mershon, and "Technical Education: Its Correlation with the Industries," John Price Jackson.